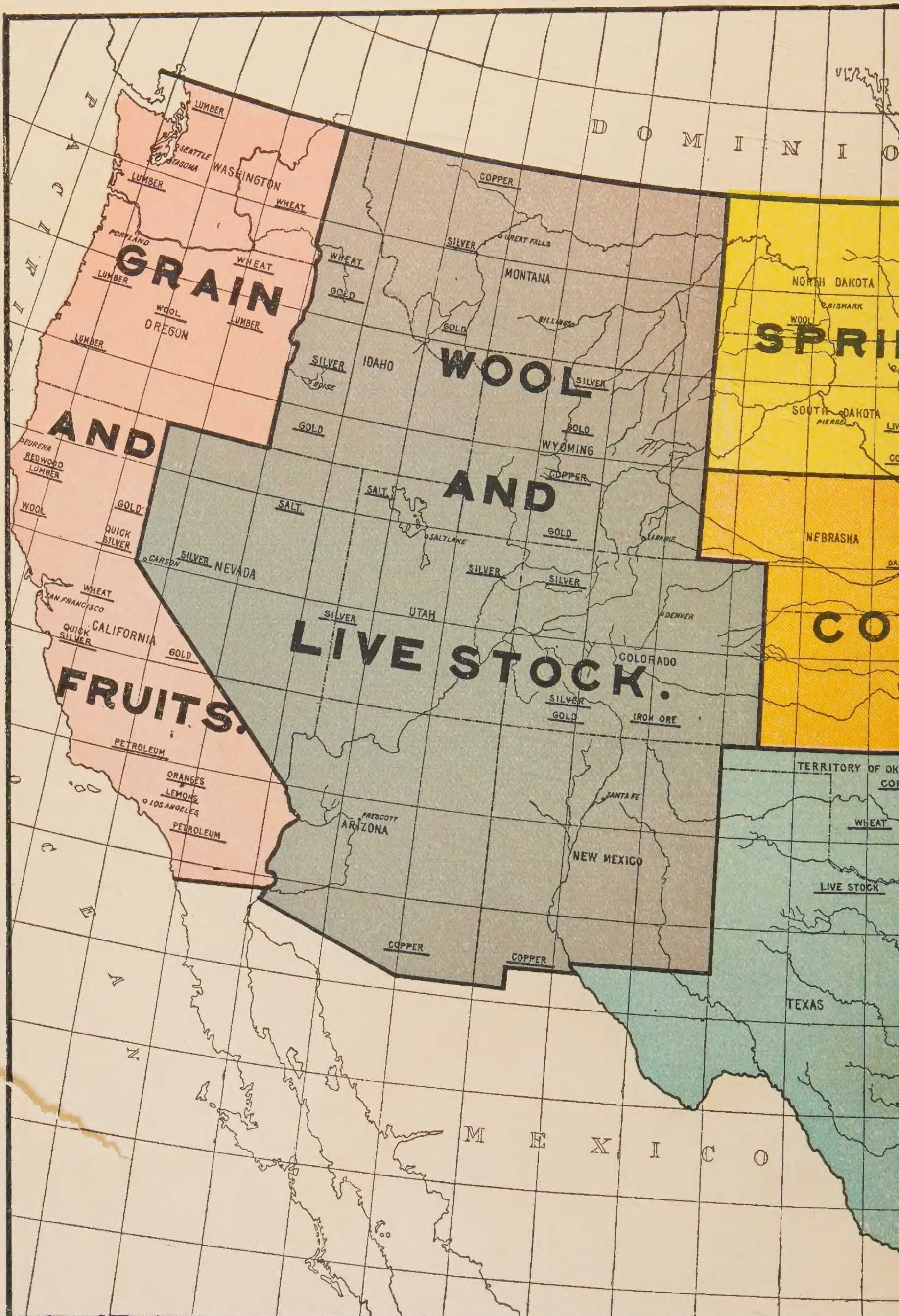
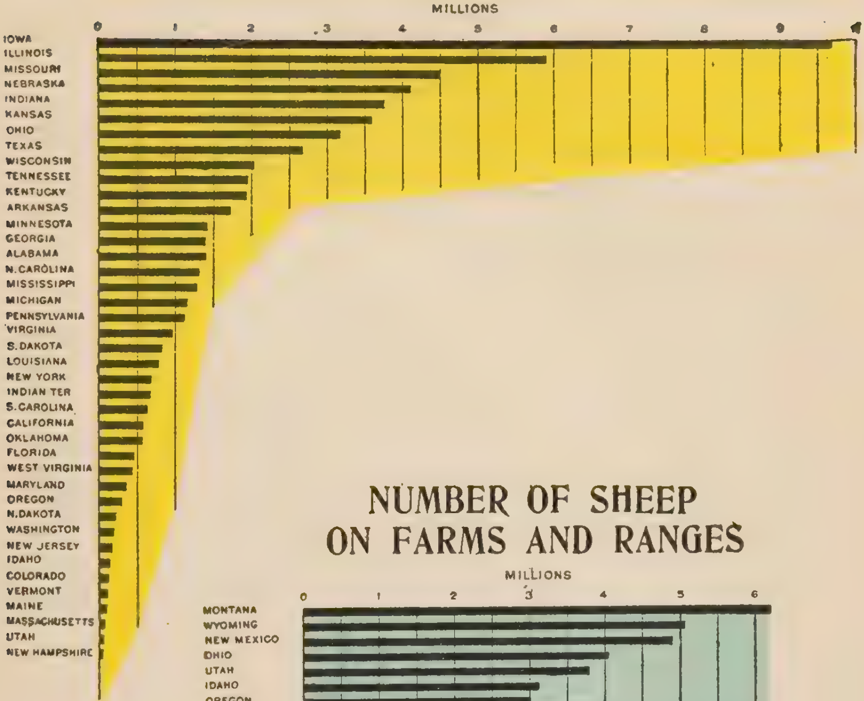
THE PRODUCTIVE AREAS OF PRINC

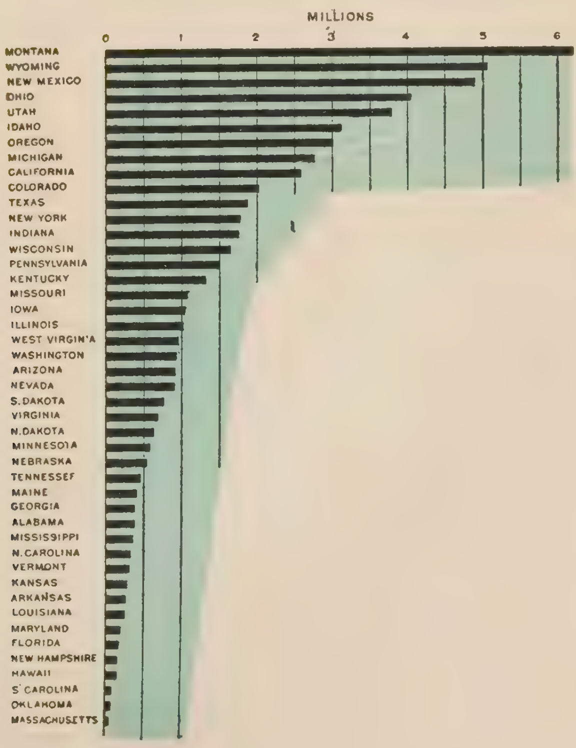


COMMERCIAL STAPLES OF THE U. S.

NUMBER OF SWINE ON FARMS AND RANGES



NUMBER OF SHEEP ON FARMS AND RANGES



The MAKING OF AMERICA

Editorial Edition
limited to one thousand copies
of which this is No. ____

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VOL. V

Agriculture

The Making of America Co.

CONTENTS

VOLUME V.

AGRICULTURE.

THE UNITED STATES; ITS SOILS AND THEIR PRODUCTS.

BY H. W. WILEY.

Henry Washington Wiley, chief bureau of chemistry, United States department of agriculture; born, Kent, Ind., October 18, 1847; graduated from Hanover college, 1867; Harvard, 1873; professor of chemistry, Purdue university, 1874–83; state chemist of Indiana, 1881–3; professor of agricultural chemistry in graduate school of Columbian university since 1895; member Jury of Awards, Paris exposition, 1900; delegate to Fourth International congress of Applied chemistry, Paris, 1900, and fifth congress in Berlin, 1903. Author: Principles and Practice of Agricultural Chemistry, 3 volumes; and contributor to the National Geographic magazine and other scientific papers.]

One of the oft-repeated theories concerning the origin of our earth is that at a remote period all the matter of which the earth consists at present was a part of the incandescent gas which filled the space now assigned to our solar system. As the cooling of this mass of gas progressed vortex rings were formed of gaseous matter. These on further cooling broke and rolled together, forming the sun, the planets, and the satellites of our present system. The next condition of the incandescent gas was incandescent liquid, which came in due season as the time rolled by. Finally, by the further process of cooling, a crust was formed upon the surface of these liquids which was the beginning of the solid surface of the earth. This crust would naturally be of the same composition as the liquid matter from which it was formed—practically homogeneous in character and consisting of the mineral matters which could only exist at that temperature.

In speaking of the soils of the United States, I would like to trace briefly their evolution from this primeval crust, which was the first ice formed on this globe. What have been some of the more active forces which have broken up this congealed mineral matter and brought it into the present condition in which we see the surface of our globe? First of all the action of water, which is and has been one of the chief disintegrating agents acting upon the earth's surface. At the time the first crust was formed over the surface of

the earth all the water which now exists must evidently have been above the earth's surface in the form of steam. As the cooling slowly progressed this steam tended to condense in the form of clouds and finally water. Thus the original rain falling upon the hot surface of the earth was at once converted again into steam, but not until it had started a certain solvent action. Water has been termed the universal solvent, and it is not difficult to see how active it must have been at the time of which I speak. The sudden cooling of the surface at the spot where a drop of water struck would tend to crack it, the hot water would dissolve quickly any of the substances soluble therein, and this continual bombardment of boiling water must have had a tremenduous effect in disintegrating the original crust formed over the earth's surface. As the earth continued to cool and diminish in size, the original surface wrinkled and formed hills and valleys. The continual descent of water would finally permit some of it to remain in the liquid state upon the earth's surface, and this coursing down the valleys continued the disintegration, both by solution and attrition. The original mineral matters were thus brought into a form of solution or suspension, and, seeking their natural chemical affinities, began to form from the first igneous rocks, the first sedimentary rocks. These are the rocks which we now see in strata, covering the greater part of the earth's surface. All these stratified rocks must have been laid down under the water, and thus we are convinced that the surface of the earth during the long period of the formation of the soil must have been alternately above and below the surface of the water collected upon the globe.

When organic life came upon the earth's surface a new disintegrating force was introduced. Organic life, even in its smallest forms, such as bacteria, acts with vigor in decomposing rocks. The larger forms, which produce rootlets, help this disintegrating process along. These roots find their way into crevices of the rocks, and tend to split them open and to admit water below their surface. Certain bacteria also tend to oxidize the nitrogen of the air and form nitric acid, known under the common name of aqua fortis, which has a vigorous solvent action on many kinds of rock.

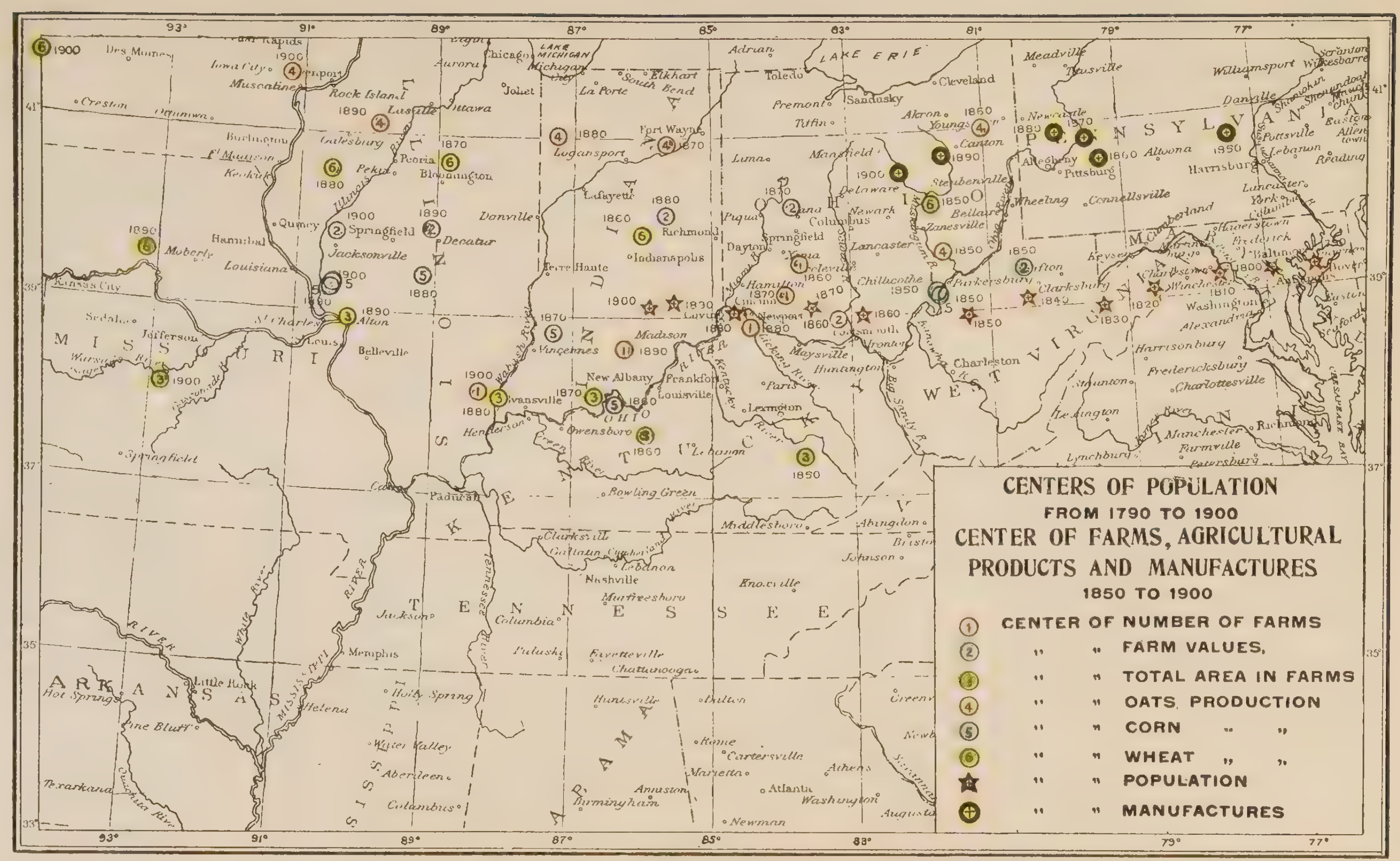
In the process of further cooling, ice was formed, and this also tended to have a disintegrating influence. Water in passing into ice increases in volume, and this tends to break and disintegrate many bodies. Rock saturated with water thus tends to break up when the water becomes ice. During the period of the ice age when large glaciers moved over the earth's surface, the crushing and grinding effects of the ice had much to do with disintegrating the rock. The vast areas of glacial drift which form the soil of many of our western states are evidences of the gigantic scale on which these ice mills of the gods slowly ground the stones of the earth into soil. When the soil is formed by the decay of rocks without the transporting action of water or ice being active, the soils are said to be formed in situ. When the products of soil disintegration are carried by water and deposited along the banks of the streams or at their mouths, the soil is called alluvial. When products of rock disintegration are carried by moving ice and deposited therefrom, they are called glacial drift. When they are carried by wind, as is often the case, they are called æolian soils. The above are some of the varieties of soils as determined by their method of formation. Soils are also classified in regard to their chemical characters; as, for instance, when formed from the decay of carbonate of lime, they are called limestone soils. When arising from the disintegration of granite, they are called granitic soils. When formed chiefly from particles of silex, they are called sandy soils. When consisting mostly of silicate of alumina, they are called clay soils, and so on.

But for agricultural purposes the soil consists of more than decayed mineral matter. By the decay of organic matter there is introduced into the soil the element, humus, which is one of its principal characteristics from an agricultural point of view. The soil is filled with millions of organisms of a lower form, without whose activity the growing of crops would be impossible. The soil, therefore, not only contains the mineral matters which are necessary to sustain the life of plants, but also those organic elements without which these mineral matters would not be available for plant growth. The three principal mineral foods of plants are potash, phos-

phoric acid, and nitrogen. Lime, magnesia, iron, and many other mineral substances are also found in plants, but these are not absolutely essential to plant growth. If, however, either nitrogen, potash, or phosphoric acid be entirely removed from the environment, it is impossible to produce a matured plant. The great bulk of the material of which plants are composed is not drawn, however, from the soil, but is taken from the air and water. Great as have been the chemical achievements of man, no chemist has yet arisen whose skill can be compared to that of the plant itself. Any chemist who to-day, with all the appliances which science has placed at his disposal, could make by synthesis the various organic compounds of which plants are principally composed would rival the fame of Berzelius, Liebig, Hoffman, Berthelot, Gibbs, or Remsen. Thus the soil must be regarded as that part of plant life which furnishes the chemical support for the growing plant, supplies it with the mineral foods essential to its growth and maturity, and favors best those conditions which enable the plant cell to elaborate the organic matters of which the matured plant is chiefly composed.

The United States is essentially an agricultural community. The basis of its wealth lies not so much in the products of its mines and manufactures as it does in those of its fields, gardens, orchards, and forests. The territory of the United States, including its new possessions, represents every variety of soil and every character of climate. It has agricultural lands in the tropics, in the subtropics, in the temperate zone, and in the sub-boreal regions of Alaska. In latitude its agricultural lands extend half way around the world. Agricultural crops are grown in the United States subject to all the vicissitudes of climate, to excessive rainfalls, to prolonged drouth, to intense heat, and to alternating frosts and sunshine.

Within the borders of the United States are grown every agricultural crop known to the world. It produces immense quantities of the cereals; of fiber plants, including especially cotton and flax, of sugar producing plants, including sugar cane, sugar beets, sorghum, and maple trees; all kinds of vegetables and fruits; medicinal plants of every variety;


CENTERS OF POPULATION
FROM 1790 TO 1900
CENTER OF FARMS, AGRICULTURAL
PRODUCTS AND MANUFACTURES
1850 TO 1900
1 CENTER OF NUMBER OF FARMS
2 " " FARM VALUES,
3 " " TOTAL AREA IN FARMS
4 " " OATS PRODUCTION
5 " " CORN " "
6 " " WHEAT " "
" " POPULATION
" " MANUFACTURES

forest products of all kinds; spices and condiments of every description.

A brief statement of the magnitude of some of the agricultural crops of the United States and the area under cultivation will be found useful. In the year 1902 the following statistics show the area under cultivation, the yield per acre, the total production and the price per unit, and in toto the magnitude of our standard agricultural crops: The crop which is universal in the United States is maize or Indian corn. There is only one state in the union in which a considerable area of Indian corn is not grown, viz., the state of Nevada, and it, as is well known, is a barren desert, except where irrigation can be practiced. The total area under cultivation in the United States in maize in 1904 was 92,231,581 acres. The total production was 2,467,480,934 bushels. The price per bushel was 44.1 cents. The total value of the crop was $1,087,461,440. The largest acreage devoted to maize in any one state was in Illinois. The smallest reported area in any one state, with the exception of Nevada, as above mentioned, was in Wyoming.

After maize the most important cereal crop in the United States is wheat. The area in 1904 was 44,079,875 acres. The average yield per acre of winter wheat was 12.5 bushels. The total quantity of wheat produced was 552,399,517 bushels, and the average price was 92.4 cents per bushel. The total value of the wheat was $510,489,874.

The area sown to oats in the United States in 1904 was 27,842,669 acres. The average yield per acre was 32.1 bushels. The total yield was 894,595,552 bushels. The average price per bushel was 31.3 cents. The total value of the crop was $279,900,013.

The area sown to barley in the United States in 1904 was 5,145,878 acres. The total yield was 139,748,958 bushels and the total value was $58,651,807.

The total area sown to rye in the United States in 1904 was 1,792,673 acres. The yield was 27,241,515 bushels and the total value of the crop was $18,748,323.

The total area sown to buckwheat in the United States in 1902 was 793,625 acres. The total production was

15,008,336 bushels and the total value of the crop was $9,330,768.

The above comprise the principal cereal crops of the United States. They do not include, however, considerable areas sown to millet, sorghum, Egyptian corn, rice, and other cereals. Summarizing the above principal crops, we find the total area under cultivation was 171,881,301 acres; total production, 4,096,474,812 bushels; total value, $1,964,582,225.

The area of cotton harvested in the United States in 1903 was 30,055,913 acres. The total production was 10,727,559 bales and in 1904, 10,011,374 bales.

The price per pound for cotton at Galveston February 6, 1903, was 9 cents, making the total value of the crop $460,068,303, that year. In 1904 it was $587,470,000.

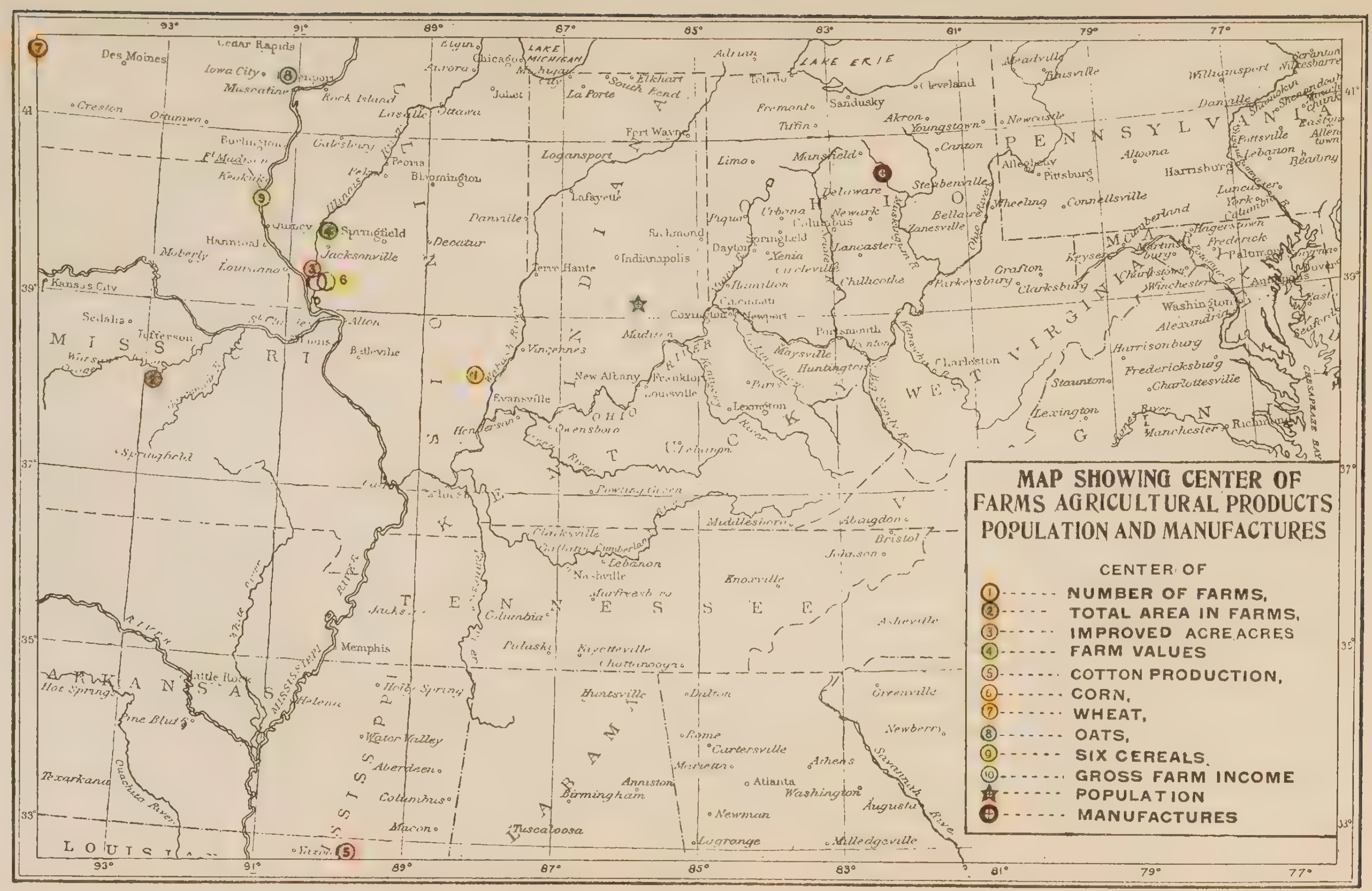
The area devoted to hay making in the United States in 1904 was 39,998,602 acres and the yield 60,696,028 tons of 2,000 pounds each. The price per ton was $8.72. The total value of the crop was $529,107,625.

The total area planted to potatoes in the United States in 1904 was 3,015,676 acres. The yield was 332,830,300 bushels. The average price per bushel was 45 cents. The total value of the crop was $150,673,392.

The total area planted to tobacco in the United States in 1904, excluding Porto Rico and the Hawaiian Islands, was 806,409 acres. The total yield was 660,460,739 pounds. The total value was $53,382,959.

The total number of tons of sugar beets harvested in the United States in 1902 was 1,777,639 tons of 2,240 pounds. The total number of tons of sugar produced was 195,800 of 2,240 pounds. The acreage in beets is difficult to determine, but it may be assumed that the average crop was about eight tons per acre, which would make the total acreage 24,475 acres. The average price of the sugar was about four cents per pound, making the total value of the crop $17,543,680.

The total quantity of cane sugar made in the United States in 1903–04 was 487,436,855 pounds. Louisiana furnished 481,600,000 pounds, Porto Rico 261,950,080, Philippine islands 49,504,000, and the Hawaiian islands 740,868,880


MAP SHOWING CENTER OF
FARMS AGRICULTURAL PRODUCTS
POPULATION AND MANUFACTURES
CENTER OF
1 NUMBER OF FARMS,
2 TOTAL AREA IN FARMS,
3 IMPROVED ACREACRES
4 FARM VALUES
5 COTTON PRODUCTION,
6 CORN,
7 WHEAT,
8 OATS,
9 SIX CEREALS,
10 GROSS FARM INCOME
POPULATION
MANUFACTURES
LAKE ERIE
LAKE MICHIGAN
PENNSYLVANIA
OHIO
INDIANA
ILLINOIS
KENTUCKY
WEST VIRGINIA
TENNESSEE
ALABAMA
MISSISSIPPI
ARKANSAS
MISSOURI
Des Moines
Cedar Rapids
Iowa City
Muscatine
Rock Island
Chicago
Springfield
Jacksonville
Quincy
Hannibal
Kansas City
Sedalia
Jefferson
Indianapolis
Evansville
Louisville
New Albany
Lexington
Columbus
Cleveland
Sandusky
Toledo
Akron
Youngstown
Canton
Mansfield
Pittsburg
Altoona
Harrisburg
Williamsport
Lancaster
Hagerstown
Frederick
Washington
Alexandria
Harrisonburg
Fredericksburg
Charlottesville
Staunton
Lexington
Richmond
Manchester
Charleston
Parkersburg
Clarksburg
Grafton
Wheeling
Connellsville
Nashville
Lebanon
Clarksville
Knoxville
Chattanooga
Memphis
Huntsville
Birmingham
Anniston
Tuscaloosa
Atlanta
Dalton
Rome
Cartersville
Newman
Lagrange
Augusta
Milledgeville
Athens
Greenville
Newberry
Asheville
Abingdon
Bristol
Little Rock
Hot Springs
Pine Bluff
Texarkana
Helena
Water Valley
Aberdeen
Columbus
Macon
Holly Springs
Springfield
Moberly
Burlington
Keokuk
Galesburg
Peoria
Bloomington
Decatur
Danville
Terre Haute
Vincennes
Lafayette
Logansport
Fort Wayne
La Porte
South Bend
Elkhart
Joliet
Ottawa
Aurora
Elgin
Lasalle
Dayton
Springfield
Xenia
Urbana
Piqua
Lima
Tiffin
Fremont
Newark
Zanesville
Lancaster
Chillicothe
Circleville
Hamilton
Cincinnati
Covington
Newport
Madison
Portsmouth
Maysville
Huntington
Steubenville
Bellaire
Delaware
Owensboro
Henderson
Bowling Green
Murfreesboro
Fayetteville
Pulaski
Columbia
Middlesboro
Johnson
Marietta
Washington
Scranton
Wilkesbarre
Reading
Lebanon
Pottsville
Danville
Allentown
Easton
York
Meadville
Titusville
New Castle
Allegheny
Winchester
Martinsburg
Chesapeake Bay
Ohio River
Ouachita River
Savannah River
Kanawha R.
Big Sandy R.
Kentucky River
Muskingum R.
Tennessee River
Mississippi River
Wabash River
93°
91°
89°
87°
85°
83°
81°
79°
77°
41°
39°
37°
35°
33°

pounds. Southern states besides Louisiana produced 5,836,-855 pounds.

Most of the cane sugar was raw, and did not bring so high a price as beet sugar, which was mostly refined. The average price was 4.6 cents per pound.

The area planted to flax for the production of flaxseed in 1904 in the United States was 2,263,565 acres. The quantity of seed produced was 23,400,534 bushels, and the value of the crop was $23,228,758. In this valuation no account is made of the value of the flax fibers.

The area in hemp in the census year was reported as 16,042 acres, yielding 11,750,630 pounds of fiber valued at $546,338.

The area in vegetables, excluding potatoes, in the census year was 2,814,139 acres, producing a crop valued at $143,-782,534.

The total area devoted to the production of peas in the census year was 968,371 acres, yielding 9,440,269 bushels valued at $7,909,074.

The total area devoted to the cultivation of peanuts was 516,658 acres, producing 11,964,959 bushels valued at $7,271,-230.

The area devoted to the cultivation of castor beans was 25,738 acres, producing 143,388 bushels valued at $134,084.

The total area planted to hops in the census year was 55,613 acres, producing 49,209,704 pounds valued at $4,084,-929.

The area devoted to the cultivation of broom corn in the census year was 178,584 acres, producing 90,947,370 pounds and valued at $3,588,414.

The total value of the fruit crops of all kinds in the United States in the census year was $131,423,517. Of this amount $83,751,840 was the value of the orchard fruit; $25,030,877 the value of the small fruits; $14,090,937 the value of the grapes, and $8,549,863 the value of the citrus and subtropical fruits.

The number of orchard trees of the different kinds in the United States in the census year was as follows:

Apple trees	201,794,764
Peach and nectarine trees	99,919,428
Pear trees	17,716,184
Plum and prune trees	30,780,892
Cherry trees	11,943,287
Apricot trees	5,010,139

The total area in fruit trees in the United States is 6,230,745 acres. The total area in small fruits is 304,029 acres, and the total value of the small fruits produced $25,030,877.

The number of olive trees in the United States in the census year was 1,540,155, and the number of pounds produced was 5,053,637.

The number of nut trees in the United States in the census year cultivated on farms was 1,649,072.

The total area under irrigation in the census year in the United States was 7,263,273 acres, and the value of the irrigated crops was $84,433,438.

The total area of the United States, including Alaska, Porto Rico, and the Hawaiian Islands, is 3,613,217 square miles, equivalent to 19,768,604,880 acres.

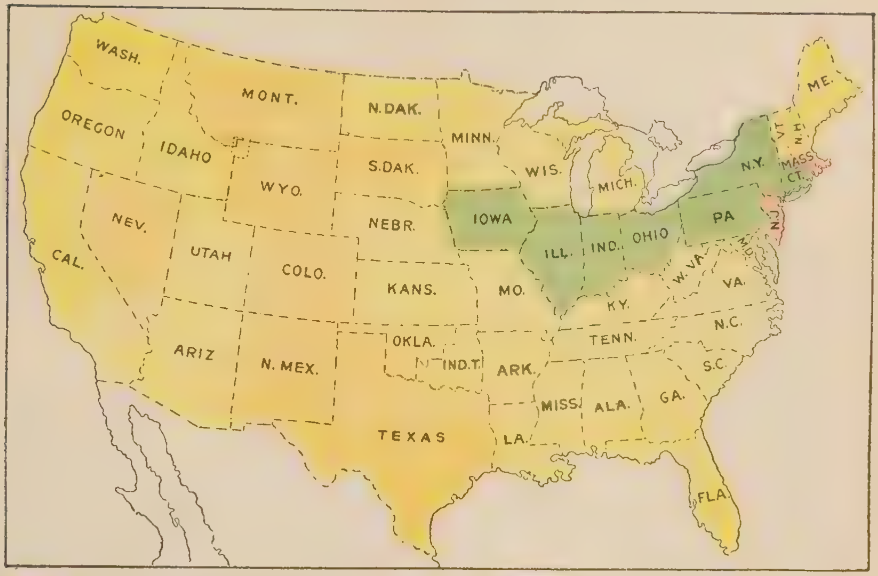
The number of farms in the United States in the census year was 5,739,657. The average number of acres in each farm was 146.6. The total acreage of the farms in the United States was 841,201,546. The value of the farm property in the United States in the census year was $20,514,001,838. The value of the farming implements and machinery was $761,261,550. The value of the live stock on the farms was $3,078,050,041.

The total value of the farms of the United States in the census year was $16,674,690,247, of which the land, with improvements except buildings, was $13,114,492,056 and the farm buildings $3,560,198,191.

Of the 5,739,657 farms in the United States 2,024,964 were operated by renters, and 3,714,693 were operated by their owners.

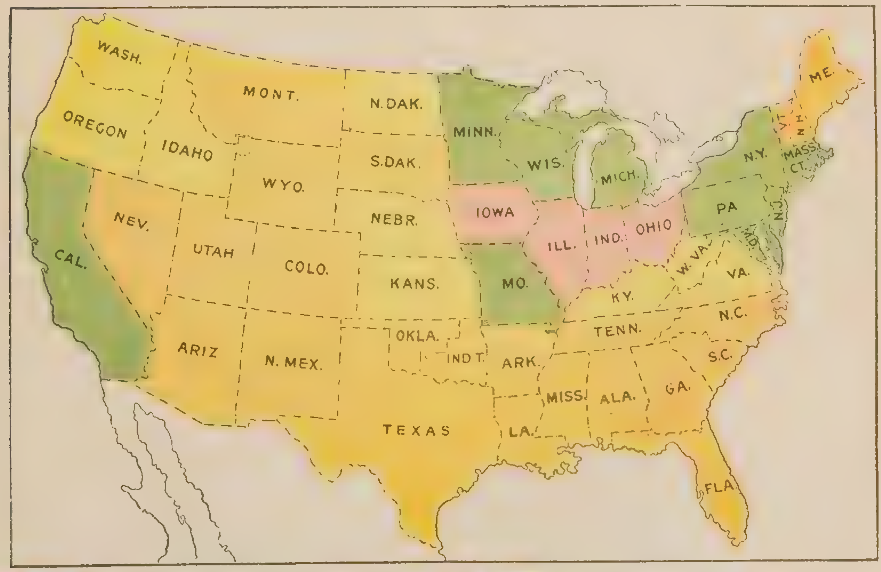
The total value of the agricultural and horticultural crops in the United States for 1902, as estimated by the statistician of the department of agriculture, is $3,500,000,000 not including live stock, the annual value of which is estimated

VALUE OF FARM PRODUCTS, PER ACRE



LESS THAN $4 PER ACRE
$4 TO $7 PER ACRE
$7 TO $10 PER ACRE
$10 PER ACRE AND OVER

VALUE OF FARM LAND, PER ACRE



LESS THAN $10 PER ACRE
$10 TO $20 PER ACRE
$20 TO $30 PER ACRE
$30 PER ACRE AND OVER

at $1,000,000,000, making the total value of the agricultural products of the United States for 1902 $4,500,000,000.

The number and value of farm animals in the United States on Jan. 1, 1905, were as follows:

Animals.	Number.	Valued at—
Horses	17,057,702	$1,200,310,020
Mules	2,888,710	251,840,378
Milch cows	17,572,464	482,272,203
Other cattle	43,669,443	661,571,308
Sheep	45,170,423	127,331,850
Swine	47,320,511	283,254,978
	173,679,253	$3,006,580,737

The total value of the agricultural exports of the United States for the year ending June 30, 1901, was $943,811,020, amounting to 64.62 per cent of the total exports of all kinds from this country. In 1904 the agricultural exports amounted to $853,643,073. Some of the principal items included in the above are as follows:

Value of cattle exported	$37,566,980
Value of sheep exported	1,933,000
Value of hogs exported	238,465
Value of bacon and hams exported.	60,341,804

In 1904 the exportation was:

Value of cattle.	$42,256,793
Value of sheep.	1,954,609
Value of bacon and hams	46,740,619
Value of pork exported.	9,527,388
Value of lard exported	46,347,520
Value of beef products exported.	35,984,949
Value of dairy products exported.	4,220,483
Value of cotton, raw	370,811,246
Value of breadstuffs	144,170,475
Value of tobacco, unmanufactured, exported	29,464,732

The foregoing data will show, in a general way, the vast agricultural resources of the United States. It is seen that we are not only able to feed our own people, but millions of people in other countries.

There is one question which constantly presents itself to the mind of the political economist, namely, Is the rate of increase in population to be diminished, or, if continued, will the food supply be exhausted in the near or remote future? In looking for answers to these questions, political economists must consult scientific agriculture. In the application of the principles of agriculture to science is found the only safe response. It is certain that under the fostering care of this country and with wise and well directed engineering, many millions of acres of rich land can be procured for agricultural purposes through irrigation. Science teaches us in many other ways the methods of making the farm, to a certain extent, independent of the variations in rainfall. The true principles of conserving moisture for the purpose of crop production, and of utilizing to the best advantage the excess of precipitation, are now well known and are daily taught to our people. Scientific forestry is increasing the number of trees and bringing large areas into tree culture which before were only featureless plains. What the effect of tree planting will be upon the climate is not known with certainty, but the general impression is that the more abundant the growth of trees, the more readily is moisture preserved for agricultural purposes, while the intensity and extent of floods is diminished.

The true principles of fertilization are annually increasing the average product of the older farm lands of the community. The principles of cattle feeding are introducing important economies into the utilization of farm products. We have no reason to think that the average wheat crop, for instance, in the United States would not increase in the amount grown per acre. An increase of a single bushel per acre will give, in round numbers, an increase of sixty million bushels to the crop. The scientific farmer can readily double and treble his crop, and so, without increasing the acreage, supply double or treble the amount of wheat. The same principle is true of other crops. The future soil fertility will increase, not diminish. The average output of each acre will grow. While the capacity of the mouth to consume remains constant through all centuries, the capacity of the hands to furnish food is constantly increasing. We need not fear,

therefore, a period of world starvation due to the exhaustion of the food producing capacity of the soil. If universal hunger does come, it will not be from this cause. It may be—I would not deny it—that the final fate of man on earth is starvation or freezing, but the remote future at which such calamities can occur makes their event for practical purposes infinitely removed. We are now feeding, within the boundaries of the United States, eighty million people. When in a hundred years from now we are feeding two hundred million people, the quantity of food per head will be no less abundant than at present. In those days now so near at hand agriculture will be more a science and more an art. The fields will all be gardens, and the forests sources of income without destruction. The life of man will be full of amenities which are now denied the tiller of the soil, and the true aristocracy of the earth will be composed of those in direct touch with earth herself.

THE AMERICAN FARMER OF TO-DAY.

BY JAMES WILSON.

[James Wilson, secretary of agriculture; born, Ayrshire, Scotland, August 16, 1835; came to United States in 1852 and settled in Connecticut; went to Iowa in 1855; engaged in farming, 1861; member of the twelfth, thirteenth and fourteenth assemblies of Iowa; member of congress, 1873–7 and 1883–5; regent, state university of Iowa, 1870–4; director, agricultural experimental station, and professor of agriculture, Iowa Agricultural college, for six years; appointed secretary of agriculture, March 5, 1897.]

Favored with continued prosperity, the farming element of the people has laid broader, deeper, and more substantial the foundations of a magnificent agriculture. Thus it has happened the farms of the nation have been that sustaining power upon which a basic dependence must be placed in all stresses by a people endeavoring to maintain economic self sufficiency.

As great as the financial successes of agriculture were in 1903, hitherto without equal, those of 1904 advanced somewhat beyond them. While some products have fallen behind in value others have more than filled the deficit, and the general result is that the farmers have produced in value much more wealth than they ever did before in one year.

One conspicuous item that has contributed to this is the corn crop. With a quantity closely approaching 2½ billions of bushels, near the record crop of 1902, the high price of this crop gives a farm value much greater than it ever had before, far exceeding a billion dollars. With this crop the farmers could pay the national debt and the interest thereon for one year, and still have enough left to pay the expenses of the national government for a large fraction of a year. The cotton crop, including seed, became the second one in value in 1903, and remained so in 1904. It is now too early to state even with approximate accuracy what the farm value of this crop is, but indications are that the farm value of lint and seed must reach $600,000,000. In this case, as in the case of all other statements herein made concerning crop values for 1904, it must be borne in mind that the amounts

have not been finally determined, that the figures may be considerably changed when the annual estimate is made in the usual way, and that the values are at the farm, and are not commercial values at the exchange or anywhere else.

Hay and wheat are contending for the third place in point of value, although for many years one or the other has held second place or been next to corn. It is expected that these crops, hay and wheat, will together be worth on the farm this year nearly as much as the corn crop, or appreciably more than one billion dollars. Although the wheat crop has a considerably lower production than in any year since 1900, the farm value per bushel is higher than at any time since 1881, so that this is undoubtedly, by a considerable margin, the most valuable crop of wheat ever raised in this country.

It now seems probable that potatoes and barley reached their highest production in 1904; that the oat crop was never so large by 60,000,000 bushels, except in 1902; and that more rice was produced than in any previous year by toward 300,000,000 pounds, so that the present crop of rice has a commercial estimate of 900,000,000 pounds.

The principal crops that are valued annually by commercial houses have an aggregate farm value of approximately $3,583,339,609. The same crops in 1903, as finally estimated, had a farm value of $3,156,099,392 and had a census value for 1899 of $2,526,345,478. In these principal crops, therefore, the farmers find an increase in value for 1904 of 14 per cent over 1903 and of 42 per cent over the census year five years ago.

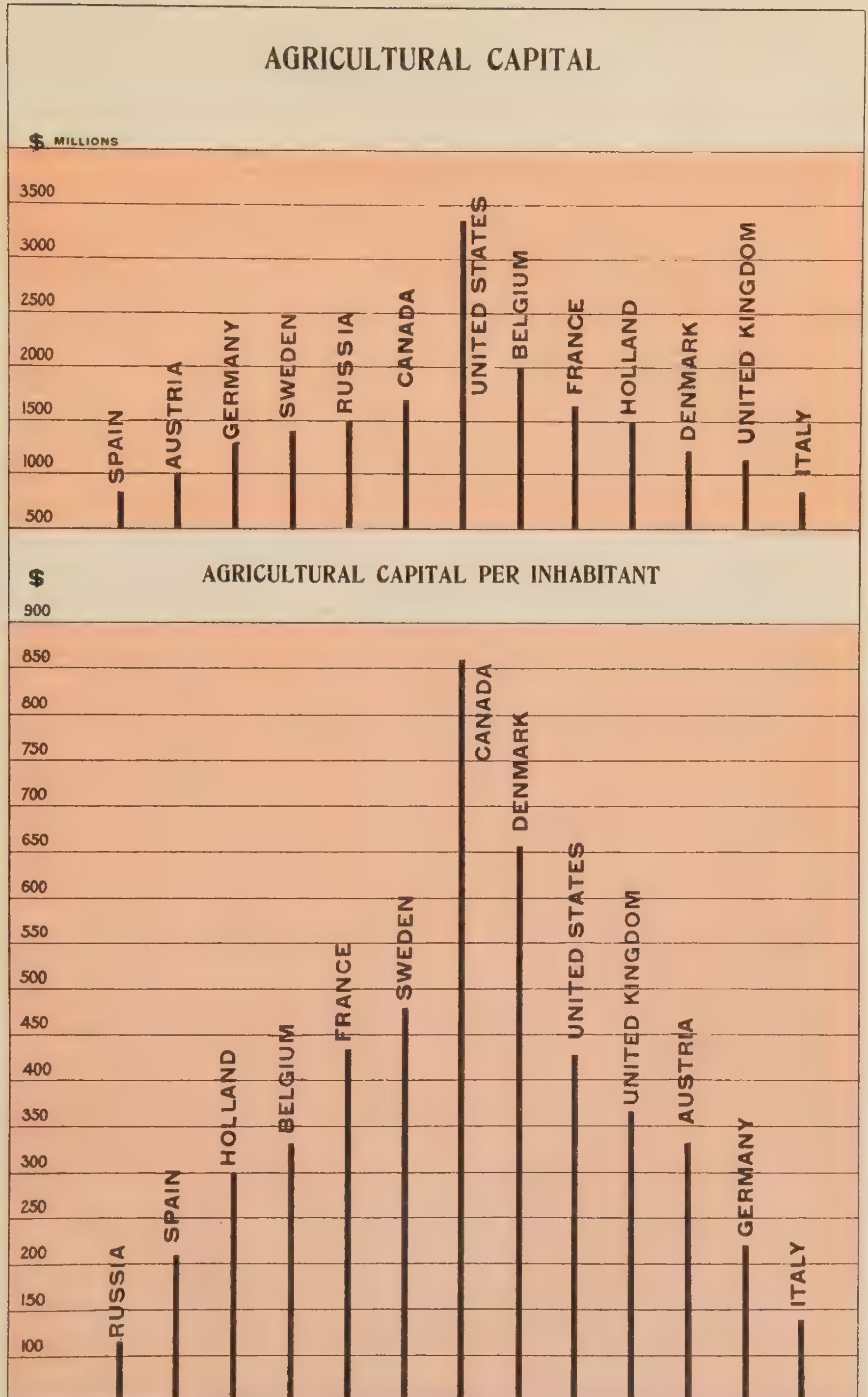
On account of the difficulty of estimating the present number and value of farm live stock, it must be sufficient to compare the farm equipment in this respect at the beginning of this calendar year as determined by the agricultural department with similar statements made for 1903. Farm horses have increased slightly in number and more in value, and in the aggregate they never were so valuable as in 1904, with a total of $1,136,940,298. The value of farm mules also reached its highest point in 1904, $217,532,832. Cattle have declined a little in number and more in value, and the same is true with regard to sheep and hogs; but the steady advance of

poultry in number and in the quantity and value of products leads to some astonishing values for 1904, when the census ratios of increase from 1890 to 1900 are extended to the present year. The farmers' hens are now producing $1\frac{2}{3}$ billions of dozens of eggs yearly, and these hens during their busy season lay enough eggs in two weeks, at the high prices of eggs that have prevailed during the year, to pay the year's interest on the national debt.

After a laborious and careful estimate of the value of the products of the farm during 1904, made within the census scope, it is safe to place this amount at $4,900,000,000, after excluding the value of farm crops fed to live stock in order to avoid duplication of values. A similar estimate made for 1903 gives $4,480,000,000, and the census total for 1899 is $3,742,000,000. It is by no means to be admitted that these figures represent fully the value of the wealth produced on farms. Within the limits of ascertainable values, the farms of 1904 produced an aggregate wealth with a farm valuation that was 9.65 per cent above the product of 1903, and 31.28 per cent above the figures for the census year 1899.

An occupation that has produced such an unthinkable value as one aggregating nearly $5,000,000,000 within a year may be better measured by some comparisons. All of the gold mines of the entire world have not produced, since Columbus discovered America, a greater value of gold than the farmers of this country have produced in wealth in two years; one year's product is over six times the amount of the capital stock of all national banks; it comes within three fourths of a billion dollars of equaling the value of the manufactures of 1900, less the cost of materials used; it is twice the sum of our exports and imports for a year; it is two and a half times the gross earnings from the operations of the railways; it is three and a half times the value of all minerals produced in this country, including coal, iron ore, gold, silver, and quarried stone.

In the exportation of their surplus during the year ending June 30, 1904, the farmers of the country kept well up to the high level of recent years. The average annual value of the exports of farm products during the five years 1899–1903


AGRICULTURAL CAPITAL
$ MILLIONS
3500
3000
2500
2000
1500
1000
500
SPAIN
AUSTRIA
GERMANY
SWEDEN
RUSSIA
CANADA
UNITED STATES
BELGIUM
FRANCE
HOLLAND
DENMARK
UNITED KINGDOM
ITALY
AGRICULTURAL CAPITAL PER INHABITANT
$
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
RUSSIA
SPAIN
HOLLAND
BELGIUM
FRANCE
SWEDEN
CANADA
DENMARK
UNITED STATES
UNITED KINGDOM
AUSTRIA
GERMANY
ITALY

was $864,930,137, and the value for 1904 was but little below, or $859,170,582. The year 1904 was exceeded by only two years, 1903 and 1901, in the value of exported farm products.

On the other hand, the imports of farm products for the fiscal year 1904 were higher in value than ever before, this value being $462,384,570, leaving an apparent balance of trade in farm products in favor of this country of $396,786,012, or the lowest balance in these products since 1897. The balance declined $25,495,220 in 1904. This is accounted for on the side of imports mostly by increases in the imports of coffee, wool, tea, cocoa, and chocolate; and on the side of exports it is accounted for principally by a decrease of over $72,000,000 in the value of exported grain and grain products which was not balanced by an increase of about $55,000,000 in the value of exported cotton. During the last fifteen years the apparent balance of trade in favor of this country, all articles considered, was $4,384,574,143. This was owing en-entirely to the balance of trade in farm products, which during the same time amounted to $5,202,551,016, and was large enough to leave the above mentioned balance of trade after sustaining adverse balances in products other than those of the farm, amounting to $817,976,963.

The subject of the achievements and financial condition of the farming population may be pursued farther. While the farmers have been increasing their annual product of wealth since 1899 from great proportions to still greater ones, the value of their farm property has gone on increasing. Ratios of increase from the last three censuses indicate that since 1900 the farm lands with improvements, including buildings, have increased in value 1⅔ billions of dollars; the implements and machinery, over $100,000,000; the principal classes of live stock, $240,000,000. Hence the apparent total of the increase in the value of farms and farm property within four years amounts to about $2,000,000,000, a total that seems to be under the fact, since it does not recognize the marked increase in cotton, corn, wheat, and other lands with high crop values. The cotton crop brought to planters not merely an increased price per pound, but it at once made cotton

lands more valuable to the extent of several dollars per acre, according to numerous reports received by the department.

The improved financial condition of the farmer is indicated expressively by deposits in banks in several states in which there is so little manufacturing and mining that the conditions are chiefly created by agriculture. The three agricultural states, Iowa, Kansas, and Mississippi, may be selected for a comparison with the United States as a whole. Individual deposits in the national banks of Iowa increased from June 30, 1896, to October 31, 1904, 137 per cent; Kansas, 212 per cent; Mississippi, 286 per cent; the United States, 92 per cent, or much below the increases of the states named. In the state and private banks deposits during this time increased 128 per cent in Iowa, 227 per cent in Kansas, 306 per cent in Mississippi, and 185 per cent in the United States. In the savings banks of Iowa the increase in deposits was 215 per cent, as compared with 53 per cent for the United States. All kinds of banks being combined, the deposits increased 164 per cent in Iowa, 219 per cent in Kansas, 301 per cent in Mississippi, and 91 per cent in the United States.

A similar comparison favorable to the agricultural states may be made with regard to the number of depositors. In the savings banks of Iowa the number of depositors increased 209 per cent from 1896 to 1904, and in the United States 36 per cent. For national banks, comparison may be made between highly industrial and agricultural states as follows: The number of depositors increased from 1889 to 1903 by 145 per cent in Massachusetts, 117 per cent in New York, 258 per cent in Kansas, and 263 per cent in Mississippi. The increase in Iowa was 184 per cent, the low figure being accounted for by the large development of savings banking. The comptroller of the currency has ascertained the average amount of the daily deposits in national banks, and from his statement it appears that the average daily deposits in October in the national banks of Kansas increased 625 per cent from 1889 to 1903, in Iowa 105 per cent, in Mississippi 89 per cent, in Massachusetts 106 per cent, and in New York 207 per cent. The farmers' rate of financial progress, as evidenced by the foregoing statements, need fear no comparison with that of

any other class of producers. The farmer may not become a millionaire, but he is surer than the millionaire to retain his wealth and to have independence in living.

The diffusion of well being among farmers throughout all parts of the country is one of the most conspicuous features of the recent agricultural development. This attracted attention a year ago and is now even more noticeable; because the great south is more especially enjoying this growth of well-being, owing to the enhanced value of the cotton crop in addition to the general progress in agriculture. The eastern farmer, who was long on the verge of bankruptcy in competition with the virgin soil and rapid expansion of the northern half of the Mississippi river valley, has survived that competition and now enjoys more normal conditions, owing to the creation and maintenance of many large near-by markets by many varied industries. The Pacific coast has long been prosperous with its world famed specialties; the mountain states are glad with the fruits and promises of irrigation; in the older prairie states the farmer has seen his land go from $1.25 an acre, or from a homestead gift, to $100 and $150; and the "Great American Desert," as it was called when it was nothing but a buffalo range, is now peopled by a progressive race of farmers, whose banks are filled to overflowing with the proceeds of their products.

THE FIRST AMERICAN FARMERS.

BY GEORGE K. HOLMES.

[George Kirby Holmes, statistician; born, Great Barrington, Mass., May 10, 1856; educated in the public schools; studied law and admitted to Massachusetts bar in 1877; special agent in charge division of farms, houses and mortgages, United States census, of 1890; now statistical expert in charge of domestic crop reporting, United States department of agriculture; Author: Farms and Homes, Real Estate Mortgages; writer on economic and statistical subjects.]

Indians carried on agriculture in a primitive and very limited way in the region now embraced in the United States before the country was inhabited by the white race, and to their crude agriculture they joined the harvesting of the wild products of nature.

The farming of Indian corn, practiced on the eastern side of North America by the Indians, was to burn off the forest, scrape up the top soil into little hills, and plant the seed therein. Indian corn, or maize, was indigenous, and the Indians raised it from time immemorial. Women did the work, and the only implements were their fingers, a pointed stick for planting, and a clam shell or the scapula of an animal for a hoe. At the time of harvest the ears of corn were stored in a cache, or were hung up to dry, held together by the braided husks.

Tobacco was another plant indigenous to America, and the Indians, who had learned its narcotic property, were in the habit of smoking the leaves after they had been dried.

The Indians of northern California gathered the seeds of wild plants for food and roasted them on hot stones, to be ground afterwards into coarse flour by a stone operated in a hollow in a rock. Mojave Indian women planted gourd seeds in the crevices of rocks, and when the gourds were ripe gathered enormous quantities of them. Especially along the whole western coast of North America, Indian women gathered wild hemp, agave, and other textile plants; they dried the leaves or stocks, macerated them in water, extracted the fiber, and spun it on their naked bodies without

the use of any implement whatever, and then made fabrics for domestic use.

Throughout the great lakes country the Indian women beat the heads of the wild rice plants while holding them over their canoes; having fanned the chaff away by using a large tray, they ground the rice in a mortar and cooked it in much the same way as corn.

The Sioux Indians beat dried wild cherries with buffalo meat to form their winter stock of pemmican. In Oregon and Washington an immense amount of food was gathered from the camass root, and also from the kouse root.

The Indians gathered the indigenous strawberries, huckleberries, blackberries, raspberries, cranberries, etc., and the chestnuts, butternuts, hickory nuts, walnuts, hazelnuts, and beechnuts. They lived also upon fish and the flesh of deer, bear, buffalo, and other wild animals, both fresh and dried.

Next the white man came. Poor in the materials of wealth, indeed almost destitute of them, a stranger in a strange land with a strange climate, and beset by native enemies, the white settler had in prospect a simple subsistence upon a few products of a crude agriculture and an insignificant dairy, with such fabrics and other products as might be obtained from a primitive domestic industry. He saw the golden ears of maize strung up in the wigwams of the Indians and learned its value as food; he learned how to plant it, and also the value of putting fish for fertilizer under the seeds.

In Georgia in 1790 the staple was tobacco, cultivated in the simplest manner, with the rudest of tools. Agriculture as we now know it can scarcely be considered to have existed. The plow was little used. The hoe was the implement of industry; made at the plantation smithy, the blade was ill formed and clumsy, and the handle was a sapling with the bark left on. After a succession of crops had exhausted the soil the cows were sometimes penned upon it. In Virginia the poor whites, who had formerly been indentured servants, were the most lazy, the most idle, the most shiftless, and the most worthless of men. Their huts were scarcely better than negro cabins; the chimneys were of logs, the chinks being filled with clay. The walls had no plaster, the windows had

no glass, and the furniture was such as they themselves made. Their grain was thrashed by driving horses over it in the open field; when they ground it, they used a rude pestle and mortar, or placed it in the hollow of one stone and beat it with another.

Each family in New England lived in a state of almost entire independence of other families and of all other communities than the one in which it lived. Beef or pork, generally salted, salt fish, dried apples, bread made of rye or Indian meal, milk, and a very limited variety of vegetables constituted the food throughout the year. The Massachusetts farmer who witnessed the revolution plowed his ground with a wooden plow, sowed his grain broadcast by hand, and when it was ripe cut it with the scythe and thrashed it on the barn floor with a flail. His house was not painted, his floor was not carpeted. When darkness came on his light was derived from a few candles of home manufacture. The place of furnaces and stoves was supplied by huge cavernous fireplaces which took up one side of the room and, sending half the smoke into the apartment, sent half the heat up the chimney. The farmer and his family wore homespun. If linen was wanted, the flax was sown and weeded, pulled and retted, and broken and swingled, for all of which processes nearly a year was required before the flax was ready for spinning, bleaching on the grass, and making and wearing. If woolens were wanted, sheep were sheared and the wool was dyed and spun and woven at home.

It was almost invariably true of all the settlers that the use and value of manures was little regarded. The barn was sometimes removed to get it out of the way of heaps of manure, because the owner would not go to the expense of removing these accumulations and putting them upon the fields.

In comparison with present conditions, the farmer's life in colonial days was a dreary one, filled with hardships and deprivations, and treading very closely upon the margin of subsistence. Those conditions continued after the republic had been established, and were not measurably ameliorated until the present century had well advanced—until an improved intelligence, the dissemination of information, and especially the work of the inventor had begun to take effect.

The first yield of Indian corn, or maize, in any considerable quantity produced in the United States by people of English blood of which we have any authentic record, was that of 40 acres in the Jamestown colony in 1609. Wheat was first sown in Massachusetts on the southern coast as early as 1602, and it was first cultivated in Virginia in 1611. Rye dates back in New England certainly to 1648, and perhaps to 1630, and oats and barley to Gosnold's colony in 1602.

The first cultivation of buckwheat dates back to 1625 or 1626 on Manhattan island.

Plymouth colony cultivated potatoes as early as 1629.

Beans have the date of 1602 on islands south of Massachusetts, the date of 1644 at Manhattan, and about the same date in Virginia.

The first apples raised in this country were possibly from trees planted on Governors island in the harbor of Boston, from which, on October 10, 1639, "ten fair pippins" were brought. Governor Endicott had on his farm in Salem, now Danvers, Mass., in 1640, the first nursery of young fruit trees that was ever planted in this country.

The English first saw tobacco cultivated and smoked in clay pipes by the Indians in Virginia in 1585, and the cultivation of tobacco was introduced into the Dutch colony of New York as early as 1646, when it sold for 40 cents a pound.

Flax was taken to Holland from Manhattan island as early as 1626. Hemp and flax were raised in Virginia prior to 1648. Hop roots were ordered by the governor of Massachusetts bay as early as 1628.

Silk culture was begun in Louisiana by the company of the west in 1718. It was introduced into Georgia in 1732. Connecticut began the production of silk in 1760.

Sugar cane was first introduced into Louisiana in 1751, and the first plantation was established in 1758.

The culture of rice was introduced into the colony of Carolina about 1694, the seed being obtained by the governor of the province from a ship from Madagascar.

A pamphlet published in London in 1609 predicted that cotton would grow as well in Virginia as in Italy, and the author of another pamphlet, published in 1620, mentions

cotton as a product that may be had in abundance in Virginia; and Bancroft's History of the United States says the first experiment in cotton culture in the thirteen colonies was made in Virginia in 1621, when the cotton seeds were planted as an experiment, and their "plentiful coming up" was at that early day a subject of interest in America and England. Cotton wool was listed in that year at 8 pence a pound, which indicates that it may have been grown earlier.

For many months after the arrival of the Pilgrims at Plymouth they had no beasts of burden; when at last a few cows were brought over, they were poorly fed on the coarse wild grasses, and often they died from exposure and want of proper food or fell a prey to the wolves or the Indians. Owing to the difficulties and expense of importation, the price was so high as to put them beyond the reach of many even in moderate circumstances. In the colony of Massachusetts bay a red calf soon came to be cheaper than a black one on account of the greater probability of its being mistaken for a deer and killed by wolves.

When cows were so high as to sell, in 1636, at from \$125 to \$150 at Plymouth and oxen at \$200 a pair, a quart of new milk could be bought for a penny. The ox of that day was small, ill shaped, and in every way inferior to the ox of the present time. During the early part of the last century the average gross weight of the neat cattle brought for sale to the Smithfield market was not over 370 pounds.

Dairy cattle were first brought to Virginia in 1611 and to Plymouth in 1624, from the coast of Devonshire. Some of the Virginia cattle were from the black cattle of Spain, and those brought to New York, possibly from the island of Texel on the coast of Holland, were mostly, without doubt, the black and white Dutch cattle. Those on the Delaware were brought from Sweden; those in New Hampshire were the large yellow Danish cattle, and, as the earlier importations were the most extensive that were made for many years, these various stocks were crossed and thus formed the original stock of the country.

The cattle along the northern Atlantic coast fared miserably in winter, having little or no protection from storms and

cold and being poorly fed on hay made from overripe swale grass and salt grass cut from the marshes. It was a common opinion in the Virginia colony that the housing and milking of cows in the winter would kill them.

The first horses taken from Europe to the western hemisphere were brought over by Columbus on his second voyage, in 1493. In 1527 forty two horses were landed in Florida and perished soon after their arrival. The wild horses of the southwest are probably descendants of the fine Spanish horses abandoned by De Soto on the failure of his expedition. In 1604 a French lawyer brought over horses to Acadia, and these probably laid the foundation of what are now known as Canadian ponies. In 1609 horses were brought to Jamestown, and in 1629 were introduced into the colony of Massachusetts bay. Horses were brought to New York in 1625 from Flanders. These importations seem to have been the original stock from which the race of American horses was constituted. But the horses of the United States, as in the case of other farm animals, have been much improved and diversified in special qualities during the last twenty five years or so by the importation of thoroughbreds from Europe and by well directed breeding.

It is probable that the first sheep in this country came to Virginia in 1609 from England. About 1625 some sheep were brought to New York by the Dutch West India company from Holland. Sheep were brought into the Plymouth colony and that of Massachusetts bay very soon after the settlement.

De Soto probably brought the first swine into this country in 1538 from Cuba, and these were landed in Florida. They were probably descended from some brought over by Columbus in 1493. The Portuguese brought swine into Nova Scotia and Newfoundland as early as 1653. The London company imported swine into Virginia in 1609. They were introduced into the Plymouth colony in 1624 by Governor Winslow, and into New Netherlands, now New York, in 1625 by the Dutch West India company.

Although the early white settlers immensely improved and expanded the agriculture of the Indians, it is neverthe-

less true that in comparison with the agriculture of the present time that of the previous century and of the earlier half of the present century was crude, wasteful, uneconomical, expensive, laborious, and unscientific. The transition from the old to the new was gradual, but, having in mind long periods of time, it is plain that American agriculture has had two distinct periods with regard to the characterization above specified. The change has been rapid since the civil war, and the last thirty years or so stand out conspicuously as belonging to a period of development and results, having little similarity to the long preceding period beginning with the eighteenth century and approaching an end about the middle of the nineteenth.

The principal opportunity for agricultural expansion was the immense cultivable area of virgin soil awaiting primarily to be despoiled of its fertility, which was subsequently to be partly restored and maintained by means of fertilizers. The necessity for this expansion was a rapid and permanent growth of sturdy population, derived not merely from a natural increase, but largely from an unprecedented immigration from the peasant laboring classes of Europe—people who had been unable to obtain the ownership of land in a country of primogeniture, as well as people who had failed in other countries where land values were beyond their reach, and who came here with "a land hunger," where they found millions of fertile acres awaiting their acquisition at a cheap price.

The population of this country, according to the census of 1790, was 3,929,214; in 1850 it had increased to 23,191,876; in 1860, to 31,443,321; in 1880, to 50,155,783; in 1890, to 62,622,250; and various estimates of the population in 1905 place it at a figure somewhat above 80,000,000.

Since the birth of the nation there must be taken into account also the great and relative increase in the city population, which must derive its subsistence mainly from the agriculture of this country without contributing to agricultural production. The population living in cities and towns of 8,000 or more was 3.35 per cent of the total in 1790, and perhaps is about 35 per cent at the present, or more than one third of the entire population.

While marked increase in the demand for agricultural products for consumption by persons who are in non agricultural occupations has thus occurred, the government at the same time has offered to agricultural producers 800,000,000 acres of land under the homestead law at hardly more than a nominal price. Some of the states and many railroad companies have been selling land, mostly for farms, amounting in the aggregate to a vast area. The number of sales on credit of tracts of land large enough to be measured by acres, from 1880 to 1889, inclusive, was 60,431 by states and 140,190 by railroads.

While the country has been developing as above indicated, the great non agricultural populations of European countries have been relatively increasing, and have exhausted in their consumption the farm production of their own countries, especially with respect to the items of wheat, corn, and other cereals, animal and dairy products, and, to the very small extent of cultivation, tobacco and cotton, thus opening up a foreign market, which has in a large degree warranted the expansion of the agriculture of the United States, along with the other causes or opportunities mentioned.

The decided decline in the cost of transportation has also contributed largely to the transformation under consideration.

The most prominent feature in the development of American agriculture is the immense improvement in agricultural methods and machines—indeed, the word improvement is not adequate to express the change that has taken place in the methods of agriculture in this country, because the implements and machines are creations rather than improvements, and their mission has been radical and far reaching. They have reduced the amount of human labor required to produce a given quantity of crops and to cultivate given areas of land, and they have been largely, if not chiefly, instrumental in converting local markets into world markets for the principal cereals, cotton, tobacco, and animal and dairy products.

It is no longer necessary for the farmer to cut his wheat with sickle or cradle, nor to rake it and bind it by hand; to cut his cornstalks with a knife and shock the stalks by hand; to thrash his grain with a flail, nor to drive horses over it to

tread it out, nor to scrape the ears of corn against a shovel or the handle of a frying pan. It is no longer necessary for him to dig potatoes, nor to cut his grass with a scythe and to spread it with a pitchfork that it may dry, nor to pitch the hay from the wagon to the haymow in the barn, nor to pick the lint from cotton seed by hand, and so on with numerous operations throughout the whole range of agricultural work. Mechanical contrivances have largely supplanted human labor in many respects, or have improved the application of labor and increased the product of agriculture, reduced the cost of production, augumented the farmer's gross income, and made his life an easier one than it was before the machine period.

This country has come to be without a peer in the manufacture of agricultural implements and machines, both in quality and number. In 1904 the product was far above $100,000,000 in value. One of these establishments for the manufacture of implements (the largest in the world), making various kinds of mowers and reapers, corn harvesters, corn huskers and shredders, and hayrakes, turns out 187,760 machines annually, or, on an average, one in less than a minute for every working day

Along with the application of invention have grown up numerous agencies for educating and training the farmer in agriculture, for disseminating information with regard to improvements, and for stimulating among farmers the associative spirit and increasing the benefits to be derived from co-operation.

The first of these agencies, chronologically, consisted of voluntary organizations for the promotion of agricultural interests. These, under various titles, existed in the colonies even before the beginning of this century. We have records of five established during the decade of 1785–1794, in the following states and in order named: Pennsylvania, South Carolina, New York, Massachusetts, and Connecticut. This method of aid to agriculture has constantly increased during the nineteenth century, and agricultural societies, the name generally applied to them, have multiplied so that at the present day there are probably few counties in the United

States where some form of agricultural society does not exist, while all the leading agricultural industries are represented by state and, in many cases, by national organizations.

Many of these voluntary associations receive state aid, and especially is this true of those organized mainly for the purpose of holding annual fairs. About 1,500 such associations are now in existence, extensively distributed throughout the country, but more especially throughout the north central and North Atlantic states. Of farmers' clubs, it is sufficient to say their name is legion. Another of these agencies consists of the commissioners of agriculture or boards of agriculture of the different states, and almost every state has some official organization in the interest of agriculture. To these must be added the agricultural colleges and the experiment stations, in which the federal and state governments co-operate.

Finally, the most important of the agencies referred to is the department of agriculture itself, which began as an insignificant division in the patent office, department of the interior, in 1839, became a department under a commissioner in 1862, and in February, 1889, was erected into an executive department under a secretary, who is a member of the cabinet.

Important and extensive collections of statistical information with regard to farms and their products have been made by national and state censuses.

The first statistics of agriculture collected by a United States census were obtained in 1840, within limits much narrower than those adopted in the censuses of 1890 and 1900.

At the present time it is the policy of the census office to procure an inventory of farm property and products, with detailed statements for acreage, values, quantities, and numbers of live stock, as far as applicable. No other country takes such a thorough, extensive, and detailed census of agriculture as does the United States.

Besides the principal boards of trade, there are many in the United States whose object is to stimulate concerted action by manufacturers, merchants, financiers, and persons especially concerned in carrying on the distributive processes.

About 800 of these boards of trade have a national association. which speaks powerfully for interests representing many hundreds of millions of dollars of capital, and which substantially represents the class of persons known as middlemen, who distribute the products of the farm. But this national association does not include all of the boards of trade, chambers of commerce, and produce exchanges. These in the aggregate number between 1,300 and 1,400, the largest number among the states being found in New York; second to which stands Pennsylvania; third, Ohio; and, fourth, Massachusetts.

There is a class of these boards of trade especially concerned with cotton, generally known as cotton exchanges, which are associations of middlemen with the object of obtaining information in regard to the condition of the market as influenced by demand, supply, production, available cotton, and, in some cases, of dealing in futures. They are in cities where there is a cotton market.

The progress of American agriculture up to the present time has by no means been thoroughly discussed in this paper, nor is it possible to do so within the limits of a single article; hence only a few more topics can be mentioned. First, statistics expressing development will be given.

The number of farms increased from 1,449,073 in 1850 to 4,564,641 in 1890; in 1900 to 5,737,372. During the same time the total farm acreage increased from 293,560,613 to 623,218,619 and 838,591,774, of which the increase in improved acreage was greater, both absolutely and relatively, than the increase in the unimproved acreage.

The average size of farms declined from 203 acres in 1850 to 137 acres in 1890, and to 146.2 acres in 1900, and it has been established that in the more recent years the increase in number of farms has more largely accrued to farms of medium size than to farms of the smaller and larger sizes.

The use of machines is an important element in this country's agriculture, and possibly the medium sized farm as it exists to-day is susceptible of being more economically cultivated and managed than either smaller or larger farms, and among the economic reasons for this the farm machine must be reckoned as highly important. But whatever the

explanation may be, the fact remains that the middle class farmer, according to the tendency disclosed by the census of 1890, is coming more and more to the front among agriculturists.

The value of the real estate of farms increased from $3,271,575,426 in 1850 to $13,279,252,649 in 1890, and in 1900 to $16,614,647,691. During this period the value of farm implements and machines increased from $151,587,638 to $494,247,467 and $749,775,970. These figures take no account of the vast increase in their efficiency, which has been infinitely greater than the figures express.

The censuses have very poorly ascertained the value of farm products, the statements undoubtedly being considerably under the facts. The published statement of the census of 1890 gives the value of farm products as $2,460,107,454, and in 1900 at $3,764,177,706.

Farm animals have increased as follows, as shown by national censuses: Horses, from 4,336,719 in 1850 to 14,969,-467 in 1890; mules and asses, from 559,331 in 1850 to 2,295,-532 in 1890; milch cows, from 6,385,094 in 1850 to 16,511,950 in 1890; oxen and other cattle, from 11,393,813 in 1840 to 34,851,622 in 1890; swine, from 26,301,293 in 1840 to 57,409,-583 in 1890; sheep, not including spring lambs, from 19,311,-374 in 1840 to 35,935,364 in 1890. The wool clip of the census year of 1890 amounted to 165,449,239 pounds, and in 1903, 291,783,032 pounds. The value of live stock increased during the period 1850–1890 from $544,180,516 to $2,208,767,573.

Farm animals, January 1, 1905, were as follows:

	Number.	Value.
Horses	17,057,702	$1,200,310,020
Mules	2,888,710	251,840,378
Milch cows	17,572,064	482,272,203
Other cattle	43,669,443	661,571,308
Sheep	45,170,423	127,331,850
Swine	47,320,511	283,254,978

Farm dairy products are thus stated in the census of 1890: Entire number of gallons of milk produced on farms, 7,266,392,674; pounds of butter, 1,071,745,127; pounds of cheese, 16,372,330.

In 1900 it was reported that the chickens on farms numbered 233,598,085; other fowls, 26,738,315; and that the eggs produced and sold during the census year were 1,293,819,186 dozen. The poultry statistics, however, probably fall far short of the facts.

Production of Indian corn, 377,531,875 bushels in 1840; 2,122,327,547 bushels in 1890; 2,078,143,933 bushels in 1899, and 2,467,480,934 in 1904; and the corn acreage increased from 62,368,504 acres in 1880 to 82,108,587 acres in 1899, and to 92,231,581 acres in 1904.

The wheat product was 84,823,272 bushels in 1840; 468,373,968 bushels in 1890; 547,303,846 bushels in 1899, and in 1904, 552,399,517 bushels; and from 1880 to 1899 the wheat acreage increased from 35,430,333 acres to 44,592,516 acres, and in 1904, 44,074,875.

The oat product was, in bushels, in 1840, 123,071,341; in 1890, 809,250,666; in 1899, 796,177,713, and in 1904, 894,595,552. The oat acreage was 16,144,593 in 1880, and increased to 26,341,380 acres in 1899, and to 27,842,669 in 1904.

The rye product was 18,645,567 bushels in 1840, 28,421,398 bushels in 1890, and 23,961,741 bushels in 1899, and 27,241,515 in 1904, with a decrease of acreage from 1,842,233 acres in 1880 to 1,659,308 acres in 1899, and an increase to 1,792,673 in 1904.

The cotton crop of 1850 amounted to 2,469,093 bales, and the crop increased decennially up to the census of 1890, and almost without a break annually since that year until the enormous crop of 1898–99, which amounted to 11,189,205 bales of considerably heavier weight than the bales of 1850. The yield in 1903–04 was 10,011,000 bales. The cotton acreage increased from 14,480,019 acres in 1880 to the largest acreage yet attained, 1903–04, which was 30,055,913. The cotton crop of the United States substantially dominates the world market for cotton, its proportion of the world's crop being from 80 to 85 per cent, and practically having little competition within the lines of its own grades and qualities. The state of Texas alone produces more cotton than any foreign cotton producing country

The hay production amounted to 10,248,109 tons in 1840; to 66,831,480 tons in 1890, and to 56,655,756 tons in 1899, and to 60,696,028 tons in 1904; and the acreage increased from 30,631,054 acres in 1880 to 41,328,462 acres in 1899, and to 39,998,602 acres in 1904.

From 1840 to 1890 the production of tobacco increased from 219,163,319 pounds to 488,256,646 pounds. In 1904 it was 660,460,739 pounds. The acreage in 1890 was 695,301 acres, and in 1904 it was 806,409 acres.

White potatoes are a crop of extraordinary increase, the bushels in 1850 being 65,797,896; in 1890, 217,546,362; in 1899, 228,783,232, and in 1904 it was 332,830,300 bushels. From 1850 to 1890 the production of sweet potatoes increased from 38,268,148 to 43,950,261 bushels.

The development of the agriculture of the United States has much more than kept pace with the enormous immigration, increase of population, increase of domestic consumption for food and manufactured products, and for cattle and other domestic animals. It has furnished besides an enormous surplus for export. Only the exports of the principal products can be given briefly:

The wheat export was 4,272 bushels in 1823; 4,155,153 bushels in 1860, 139,432,815 bushels in 1899, and 44,230,169 in 1904. During the same time wheat flour was exported to the amount of 756,702 barrels in 1823, 2,611,596 barrels in 1860, and 18,502,690 barrels in 1899, and 16,999,432 in 1904.

The exports of raw cotton amounted to 173,723,270 pounds in 1823, to 1,767,688,338 pounds in 1860, and to 3,773,410,293 pounds in 1899, and 3,063,192,760 pounds in 1904. The more recent product, cotton seed oil, had an export of 50,627,219 gallons, and the export trade in this product has chiefly grown up since 1889.

The hay export is relatively small, amounting to only 60,370 tons in 1904. The barley export also is comparatively small, amounting to 10,881,627 bushels.

The corn export was 749,034 bushels in 1823; it was 3,314,155 bushels in 1860, and 174,089,094 bushels in 1899, and 58,818,965 in 1904.

In 1899 the oat export amounted to 30,309,680 bushels, and 1,153,714 in 1904, and the oatmeal export was 58,042,505 pounds, and in 1904, 14,526,477. In 1899 the rye export was 10,140,876 bushels, and in 1904, 765,108.

The following are the exports of farm animals in 1899, the figures representing numbers of animals: Cattle, 389,490; hogs, 33,031; horses, 45,778; mules, 6,755; sheep, 143,286. These numbers have grown during the last twenty five years from almost nothing. In 1904 the exports were: Cattle, 593,-409; horses, 42,001; sheep, 301,313; mules, in 1903, 4,295.

The exports of beef products amounted to 19,053,800 pounds in 1866, not including preserved meats, and the entire quantity of beef products exported in 1899 was 368,666,638 pounds, and in 1903, 385,030,329 pounds; in 1903 the beef tallow exports amounted to 107,361,009 pounds. In 1903 the pork products exported amounted to 61,256,098 pounds. In 1903 the mutton exports amounted to 532,476 pounds.

A large item of export has grown up within a few years under the name of oleo oil, and its export in 1899 aggregated 142,390,492 pounds, but in 1903 it was 11,981,888 pounds.

The butter and cheese exports have in late years shown a decline. In 1899 they amounted, respectively, to 20,247,997 and 38,198,753 pounds, and in 1903, 1,604,327 and 2,250,329 pounds respectively.

For many years tobacco has been a large item of export, and its quantity has substantially remained constant for twenty five years or so. The pounds of leaf tobacco exported in 1899 were 272,421,295 and the value of the manufactured tobacco exported in that year was $5,179,012. In 1904, 305,-386,128 pounds valued at $29,464,732.

The wool export has rarely reached 1,000,000 pounds, although in 1896 it almost equaled 7,000,000 pounds. In 1904 it was 319,750 pounds.

The decade 1840–1850 marks an epoch in the history of agriculture. The world was then making rapid strides in applied science. Railroads were rapidly extending, ocean steam navigation became established, the electric telegraph came into use, and, what was of great importance in connection with agriculture, the chemical theory of manures came

to be understood. Artificial fertilizers, made according to formulas founded on the chemical composition of the ashes of plants, began to be manufactured, and came rapidly into use. The use of nitrate of soda and superphosphate of lime was becoming common.

Along with the increased consumption of commercial fertilizers, there has been a vastly increasing realization by farmers of the value and utility of barnyard and compost manures, especially in the parts of the country where cattle are kept in stables throughout a large portion of the year. Speaking in general for the whole country, the net result of the use of fertilizers, so far, has been mainly to preserve the normal fertility and production of the soil, although farmers' experiences have numerously and extensively established the economic desirability of more intensive agriculture.

There is one prominent feature in the agricultural development of the United States that has received little public attention, and this is the extraordinary multiplication of the varieties of foods into which farm products have been converted by the slaughter house, by the packing house, by the cannery, and by the manufacture of health foods. The effect of all this upon the consumption of numerous farm products has been very considerable, and has, to some extent, revolutionized the diet of the people of this country, and presumably of other parts of the civilized world, especially of people living in cities and towns.

One does not need to go back more than a generation to find the meat supply derived from local farmers and butchers. Indeed, among the great mass of the people living outside of the cities and large towns the fresh meat supply was a matter of neighborhood borrowing; a farmer slaughtered an old cow, perhaps, and distributed some of the quarters or other portions of the carcass among his neighbors, with the expectation that they would return an equivalent when it came their turn to butcher.

Until comparatively recent years the products of the farm were distributed throughout the year for food consumption in a crude and very restricted sense. Apples and green corn were dried in the sun; Indian corn was preserved dry in

the crib; potatoes, cabbages, and turnips were kept fresh in the cellar; some beef was dried; pork and beef were pickled in brine; squashes and pumpkins were kept for some time after the harvest without rotting, and so on with a few other products of the farm and garden.

Fresh beef and mutton and pork and poultry preserved by refrigeration can now be had in all parts of the country, from the farms and ranches of the Mississippi valley, to say nothing of the improved local meat supply. Many of the principal garden products now know no season, owing to the canner and the preserver. The peach and the pear, the apricot and the plum, peas and beans, lentils and green corn and tomatoes, and many kinds of berries—and so on through almost the entire list of the fruit and vegetable products of the farm and garden—are now to be had at all times of the year, not always, perhaps, with the flavor they possessed when gathered from their vines and stalks and trees, but yet with much of their original freshness and flavor.

By means of canning and preserving the farmers' market has been enlarged both in time and space until the market for farm and garden products now extends throughout the entire year, not only to remote parts of this country, but to a large portion of the world.

One of the large western packing companies with enormous capital and business has been selected to illustrate how the extension of the farmers' market has been promoted and elaborated in recent years. This packing company owns the cars that are used to distribute its products and to collect some of them. It has 500 tank cars for transporting blood and tankage for fertilizers and various animal oils; it has 4,000 cars for transporting dressed beef and 6,500 cars for transporting fruit. From the price lists of this company, sent to its agencies throughout the United States, the following facts are extracted:

The beef carcass is cut into many different parts in various ways, all intended to meet the demands of retailers and consumers, and the different parts so cut, including all of the parts of the animal customarily eaten, number 53. With regard to meat cuttings, the numbers are, pork 29,

mutton 12, veal 5; number of boiled hams 6; varieties of sausages 43 and of delicatessen sausage 14—total varieties of sausage 57. The dried salt meats are prepared with 16 different cuttings; the bacon meats with 16. There are hams of many descriptions, and dried beef, mess pork, mess beef, pickled beef tongue, pork spareribs, mince meat in packages of numerous sizes, lard, compound lard and lard oil, neat's foot oil, and tallow oil. The canned meats include numerous varieties, among which may be mentioned corned beef, pigs' feet, gelatin, boar's bead, Oxford sausage, tongue, roast beef, boiled beef, chipped beef, deviled ham, potted ham and tongue, minced ham, chicken, turkey, chile con carne, pork and beans, ox marrow, chicken tamale, and sauerkraut, and Vienna sausage, etc. There are to be mentioned also some of the canned soups, as ox tail, mock turtle, tomato, consommé, chicken, beef, mutton, vegetable, puree of green peas, and so on.

The extracts of beef are liquid and in tablets of various descriptions. The pickled tongues, pork hocks, and pigs' feet are of nine descriptions, and there is poultry of all sorts, and fresh eggs and canned eggs, ducks, quails, venison, prairie chicken, pigeons, squabs, and even frogs' legs.

Cotton seed is a very marked instance of a former by-product of the farm which has become of enormous value and of varied uses. The meats are made into oil cake and oil meal for feeding stuff and for fertilizers; into crude oil, cotton seed stearin, salad oil, cottolene, miners' oil, and soap, and the oil is exported to Europe and brought back again as olive oil. The hulls may be used for making paper; they are made into bran for cattle food; they are used for fuel, and are an important contribution to the list of fertilizers.

Here is an enormous source of wealth which science has given to the farmers within comparatively recent years. The estimated value of the cotton seed of a 10,000,000 bale crop of cotton (to the planters) is about $30,000,000, and this value is now almost entirely appropriated by them.

FIFTY YEARS OF AMERICAN AGRICULTURE.

BY LE GRAND POWERS.

[Le Grand Powers, chief statistician of the United States census; in charge of agriculture since 1899; born, Preston, N. Y., 1847; educated at Tufts college and Iowa State university in 1872; engaged in ministry, 1874–90; commissioner of labor, Minnesota, 1891–9. Author: Minnesota Bureau of Labor Biennial Reports, Farmer Hayseed (a reply to Coin's Financial School), and contributor to magazines, journals, and reviews.]

The census of agriculture of 1850 reported 1,449,073 farms, and that of 1900, 5,739,657, an addition in fifty years of 4,290,584 farms, or nearly three times as many as had been established in the preceding two hundred and fifty years of settlement. The same period witnessed an increase in national population from 23,191,876 to 76,303,387, and in that of cities with 8,000 inhabitants and over, from 2,897,586 to 25,031,505. Notwithstanding this unprecedented growth in urban population, the increase in the number of farms was relatively greater than that in population, being in the ratio of 4 to 3.3. In 1850 there was 1 farm for every 16 persons in the United States; in 1900 there was 1 for every 13.3 persons. In proportion to population, therefore, there were 6 farms in 1900 where there were only 5 in 1850, representing an addition of 1 farm for every 12.4 persons added to the national population.

If only the population outside of cities with 8,000 inhabitants and over be considered, the following figures are obtained: In 1850 there was 1 farm for every 14 of the 20,294,290 persons composing this population, while in 1900, when the corresponding population was 51,271,882, there was 1 farm for every 8.9 persons. In proportion to the nonurban population, there were 7 farms in 1900 where there were only 4 in 1850, representing the establishment of 1 farm for every 7.2 persons added to the population outside of cities of 8,000 inhabitants and over. Compared with the nonurban population there were nearly twice as many farms established during these fifty years as in the period between the settlement of

Jamestown and the middle of the nineteenth century. This large actual and relative increase in the number of farms since 1850 is a fact of great social importance, and is reflected in all the statistics of agriculture.

From 1850 to 1900 the reported area of farm land increased from 293,560,614 acres to 841,201,546 acres. The new land opened for agricultural uses was 547,640,932 acres, or nearly twice as much as that converted from the wilderness into farms prior to the middle of the century. The improved land in farms, which was only 113,032,614 acres in 1850, advanced to 414,793,191 acres in 1900, an increase during the half century of 301,760,577 acres, which increase represents nearly three times the area under improvement in 1850.

The productive power of the farm naturally increases in proportion to the increase of its improved area. In 1850 the farms of the country not only supplied the people with food and with most of the raw material for clothing, but furnished also considerable quantities of products for export. Since that time the crop producing area has increased so much faster than the national population that the country now supplies its people with more and better food and with more material for clothing than ever before, and at the same time exports agricultural products to an extent that was impossible until recent years. Had the area of improved land increased at no greater rate than the national population (229 per cent), it would have been only 371,877,300 acres, or 42,915,891 acres less than it actually is. All this surplus area is available for the production of food supplies for foreign nations; but, in fact, owing to improved methods of cultivation and to the occupation of more fertile soils, the exportations of agricultural products from this country have increased in even greater proportion, and now have an annual value nearly, if not quite, equal to one half that of the total production of staples in 1850.

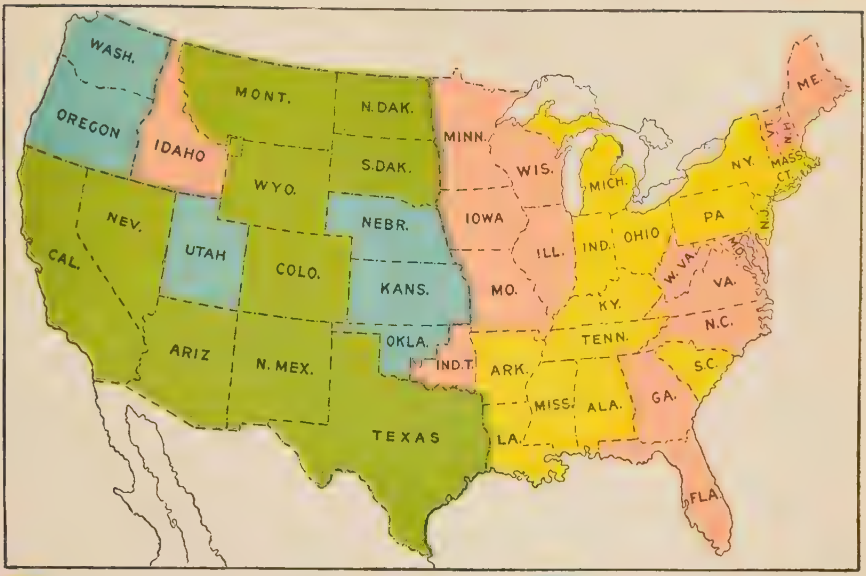
For the United States the average size of farms decreased from 1850 until 1880, since which year it has steadily increased. This was true, also, in the north central and western divisions, but in the North Atlantic states there

was a decrease until 1890, a gain being shown for the last decade only. If, however, the farm acreage reported at the census of 1880 was, as has been estimated, approximately 2,500,000 acres in excess of the actual acreage, the average size of farms in this division was smallest in 1880 and the changes have been identical in time and character with those for the United States. In the south Atlantic division there was a constant decrease from 1850 to 1900, and in the south central, from 1860 to 1890. The average for this latter group was greater in 1860 than in 1850, and in 1900 than in 1890.

This is most marked in the cotton growing states, where it is the result of a subdivision of the larger holdings and the leasing of smaller areas to tenants, the size depending upon the amount of land which the tenant can properly cultivate by his own labor. This movement began shortly after the close of the civil war, and is still in progress in most sections where large areas are devoted to the growing of cotton. Its extent may be measured by the reduction in the average area of farms in the south Atlantic states from 376.4 acres in 1850 to 108.4 acres in 1900.

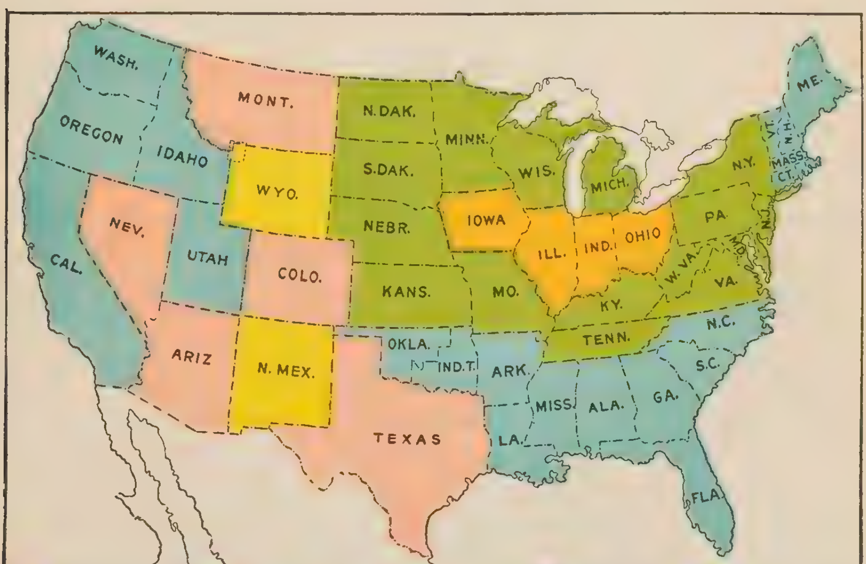
Nowhere in the northern states has there been a like decrease in the average size of farms. The average in Maine has increased from 97.2 acres in 1850 to 106.2 acres in 1900; in New Hampshire, from 116.0 acres to 123.1 acres; and in Vermont, from 138.6 acres to 142.7 acres. In most counties of these states the leading agricultural pursuit is dairying, and, owing to the fact that in this industry very small farms can not properly support a family, the farms are being sold and the land absorbed in larger holdings. This movement can be traced in all the dairy sections of the north Atlantic division. In such states as Massachusetts, New York, New Jersey, Pennsylvania, and Connecticut this increase in the size of farms in the dairy sections has been more than counterbalanced by the subdivision of old farms near cities for use in the growing of fruits and vegetables, which accounts for the decrease in the average area of the farms of these states. The same conditions have been operative in Ohio, Indiana, and Illinois, diminishing the average size of all farms

AVERAGE SIZE OF FARMS



LESS THAN 100 ACRES
100 TO 200 ACRES
200 TO 300 ACRES
300 ACRES AND OVER

PROPORTION OF IMPROVED LAND TO TOTAL AREA



LESS THAN 10 PER CENT
10 TO 25 PER CENT
25 TO 50 PER CENT
50 TO 75 PER CENT
75 PER CENT AND OVER

for those states, although not materially affecting that of farms devoted to diversified agriculture. In sections better adapted for grazing than for the cultivation of crops, as in western Kansas and Nebraska, North and South Dakota, western Texas, and in most of the semi-arid portions of the west, the average area of farms is much larger than in other parts of the country, and has tended to increase in the last decade.

Throughout the United States, the increase or decrease in the average size of farms, therefore, is due to the changes incident to the adjustment of the agricultural operations of each locality to those branches of husbandry to which it is best adapted. It may be said that the average area of farms tends to approximate the area from which the farmer possessing average capital can secure the largest returns.

The following table presents, by geographic divisions, the average number of acres of improved land per farm.

Geographic divisions.	1900	1890	1880	1870	1860	1850
The United States...	72.3	78.3	71.0	71.0	79.8	78.0
North Atlantic.........	57.4	64.3	66.6	68.3	69.0	69.3
South Atlantic.........	47.9	55.6	56.1	80.7	115.6	120.9
North Central..........	101.2	95.8	80.6	69.7	67.7	61.0
South Central..........	48.3	61.0	56.2	60.8	89.7	82.6
Western..............	111.8	157.8	185.9	168.1	106.4	51.8
Alaska and Hawaii....	129.0	....	....	....	....	....

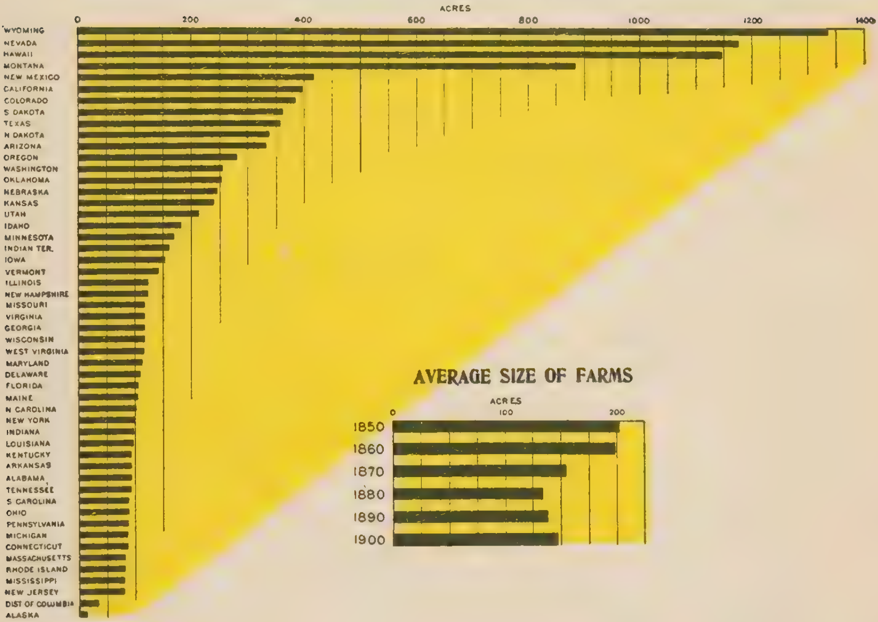
A portion of the decrease in improved farm land in these states is due to the inclusion within city limits of former farm areas, but the greater portion is due to the change in the character of agricultural operations, and the new methods adopted for securing the greatest income from farm lands. The competition of western land has rendered the cultivation of cereals, with the possible exception of corn in some localities, less profitable than formerly, and this has led to a gradual decrease in the area of land devoted to such crops. At the same time, the growth of city population in these states has stimulated certain special branches of agriculture, notably dairying and market gardening. These changes have led to a natural selection of land according to its adaptability to

special uses. The most fertile and most easily tilled lands have been retained under cultivation or have been converted into permanent meadows and made increasingly productive, while less fertile lands that are plowed with difficulty, and meadow land which can not be mown by machines, have been, in many cases, converted into permanent pastures. The resulting increased average fertility of plow and meadow lands enables the farmers to raise on a smaller area the winter feed for the animals that can be kept on the enlarged area of partially exhausted pasture land during the summer. The increasing cultivation of forage crops, the use of the silo, and the larger acreage of corn grown and fed on the farm, are all factors contributing to the same end—a decrease in the total area required to produce the winter feed for the farm animals. No such improvement has been made in the pasture lands; hence, there is a readjustment of the total farm area, involving a reduction of meadow and plow land and an increase in that used for pasture. The tendency toward this change—arising from the increased average productiveness of the soil under plow or mower—is enhanced by the custom, growing among eastern farmers, of purchasing feed produced in the west. This practice lessens the demand for meadow and plow land, and results in an increase in the area used for pasture, so that a greater proportion of farm land is each year being considered as improved.

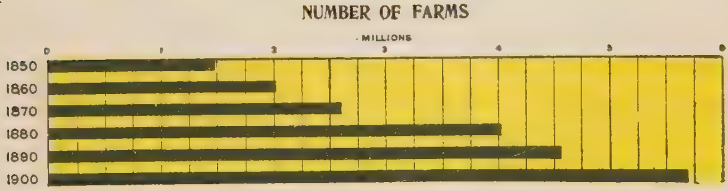
The value of farm property in 1900 was $20,514,001,838, a gain in ten years of $4,431,734,149, or considerably more than the total value reported fifty years before. The absolute increase in value for the last decade did not greatly differ from that for the ten years 1850 to 1860, which was $4,013,149,483, or from that for 1880 to 1890, which was $3,901,766,151. The percentages of gain for the three periods, however, were quite different, being for the decade 1850 to 1860, 101.2 per cent; 1880 to 1890, 32.0 per cent; and for the last decade, 27.6 per cent.

The average value per acre of all farm property in the United States increased from $13.51 in 1850 to $25.81 in 1890. In 1900 it was $24.39, the decrease being due to the extensive additions of cheap land in the west and south, which

AVERAGE SIZE OF FARMS



NUMBER OF FARMS



more than counterbalanced the actual increase in value of the great majority of American farms. The average value for the south central states reached its maximum in 1860, that for the north Atlantic and north central in 1900.

The fixed capital of agriculture, comprising the value of the land, buildings, and improvements, of implements and machinery, and of live stock, was valued June 1, 1900, at $20,514,001,838, or more than four times that of manufactures. Judged by the standard of fixed capital, therefore, agriculture leads manufactures by a ratio of more than 4 to 1.

Prior to 1850 agricultural operations, with the exception of cotton culture, were generally conducted on a small scale, and owing to the lack of railroads, production for the general market was mostly confined to territory bordering upon the oceans and upon the inland lakes, rivers, and canals. Over three fourths of the total value of farm land was found east and south of the Ohio river. The great majority of the families engaged in agricultural work lived in inferior houses and used rude implements, producing but little more than was required for their own use.

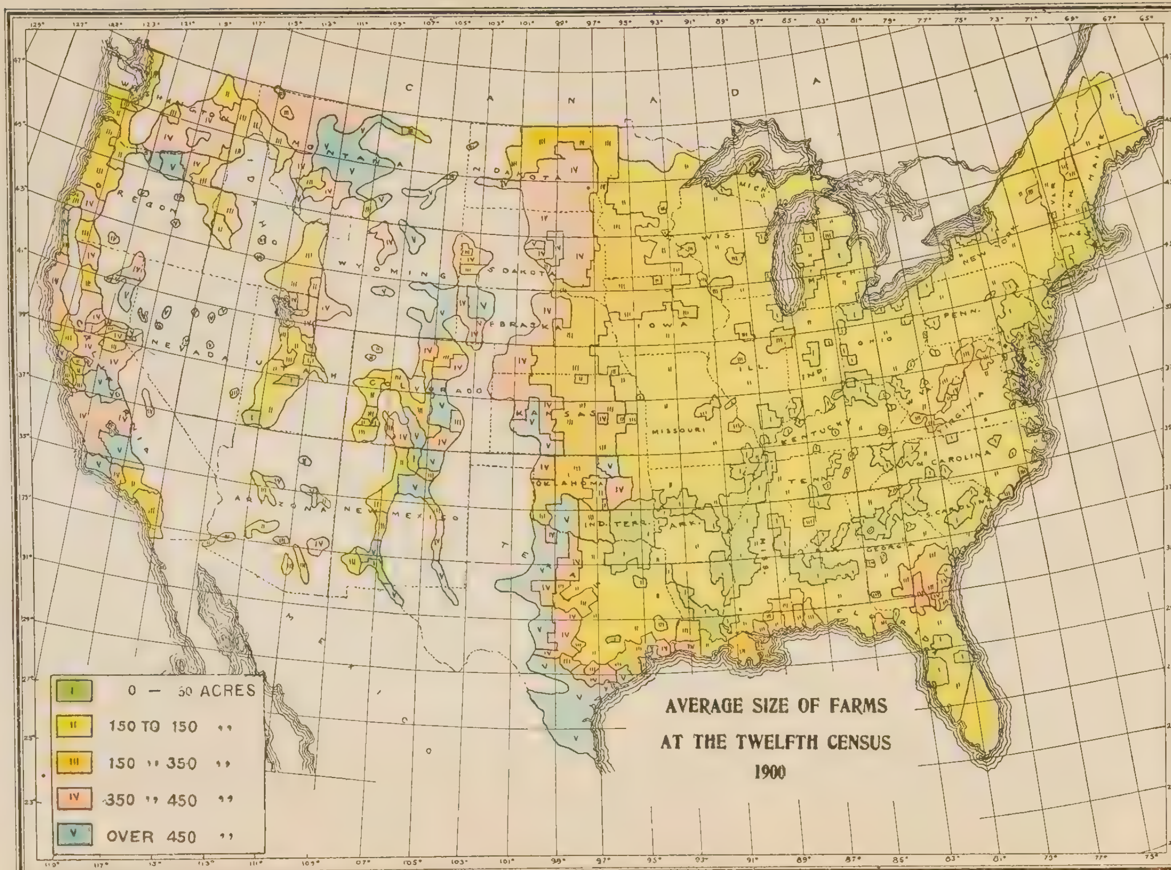
Land values reflected these conditions. The farms of the north Atlantic division, located near good markets and enjoying the best transportation facilities of the period, comprised 18.8 per cent of the total farm acreage of the country and represented 44.5 per cent of the total value. Near the cities in this section, the average land values had advanced considerably, but in more remote localities they were still low. In Connecticut and Massachusetts they were $30.51 and $32.50 per acre, respectively, while in Vermont and Maine they were only $15.36 and $12.04, the latter figure being only slightly greater than that for the north central states, where the average was $11.99. In the south Atlantic states the average value of farm land per acre was $6.17; in the south central, $6.18; and in the western states, only $1.86.

The decade 1850 to 1860 was a period when American inventors were earnestly endeavoring to improve all classes of farm implements and machinery. It witnessed the beginning of the practical use of horse driven machinery for cutting and threshing grain, the first of a series of changes

that subsequently revolutionized the methods of work on all farms in the United States outside of those devoted to cotton growing. During the decade, transportation by rail from the central west to Chicago and Milwaukee, and thence by lake and canal to the seaboard, reached such a stage of development as to enable the farmers of that section to compete successfully in the markets of the world. These factors stimulated the settlement of the north central states and assisted in opening a market for our breadstuffs in Europe. The repeal of the corn laws in Great Britain and the rapid development of manufacturing in that country contributed to the same end; and the growth of manufacturing in this country and abroad also created a demand for cotton, which, with the increasing demand for grain, gave a greater impetus to American agriculture than had ever before been experienced.

Moreover, the discovery of gold in California and Australia, and the resulting vast increase in the production of that metal affected the whole scale of prices and became a factor in increasing farm values and in bringing to this country great numbers of immigrants. The potato famine in Ireland and the revolution of 1848 in Germany also assisted in setting in motion an important movement of population toward America. These immigrants settled in all the northern states, westward as far as Wisconsin. As a rule, they were thrifty, industrious, and experienced in European methods of agriculture. The cheapness of the new lands of the west and the growing markets for American agricultural products caused great numbers of people to move from the New England and other eastern states to the middle west and southwest. From 1850 to 1860 the population of Wisconsin increased 470,490; of Michigan, 351,459; of Texas, 391,623; and that of other western and southwestern states in correspondingly large numbers. This growth was principally due to the influx of settlers.

The same decade witnessed a great development on the Pacific coast mainly due to the discovery of gold. The rapid settlement of California and the prosperity which followed stimulated the opening of new lands all along the Pacific coast. Oregon had been partly developed by the Hudson


AVERAGE SIZE OF FARMS
AT THE TWELFTH CENSUS
1900
0 — 50 ACRES
150 TO 150 ,,
150 ,, 350 ,,
350 ,, 450 ,,
OVER 450 ,,
CANADA
WASHINGTON
OREGON
NEVADA
MONTANA
WYOMING
N. DAKOTA
S. DAKOTA
NEBRASKA
COLORADO
KANSAS
OKLAHOMA
IND. TERR.
ARIZONA
NEW MEXICO
IOWA
MISSOURI
ARK.
WIS.
MICH.
ILL.
IND.
OHIO
PENN.
NEW YORK
KENTUCKY
TENN.
VIRGINIA
N. CAROLINA
S. CAROLINA
GEORGIA
MASS.
MAINE
MEXICO

Bay company and by settlers from the east who had gone overland in 1843.

The result of all these factors is seen in the increase in the number of farms, in the increase in farm acreage and in the increase in values of farm lands. The value of farm lands for the whole United States more than doubled, and a marked advance was shown in all parts of the country. The average value per acre of farm land in the United States increased $5.18, a greater gain than was chronicled in the succeeding forty years. The increase in the north Altantic states was from $26.38 to $34.74; in the south Altantic from $6.17 to $9.47; in the north central from $11.99 to $19.74; in the south central from $6.18 to $11.04; and in the western from $1.86 to $5.54.

In the decade from 1860 to 1870 the civil war directly and indirectly wrought great changes in the agriculture of the country. The organization of great armies increased the market demand for food products in the north. The supply of labor was diminished, for the time being, but was increased later by the great immigration movement that had begun in the preceding decade. Agricultural production in the north was greatly extended and land values continued to rise. Thousands of miles of railroad were constructed, and the Union Pacific, completed in 1869, opened a new pathway to the Pacific coast. The passage of the homestead law in 1862, granting land to the actual settler on the public domain, made it easier for all, and especially for those having little or no capital, to obtain farm homes, and improving transportation facilities made agriculture on the new farms profitable.

As a result, many persons, and especially soldiers of the northern army, moved at the close of the civil war from the east to the west. Land values in that section advanced more rapidly than elsewhere. In fact, the westward movement of the younger farmers and the increasing competition of the cheaper and more fertile grain fields of the west, caused land values in some parts of New England to suffer a slight decrease. The growing demand for American breadstuffs and meat products in Europe checked, for a time, the tendency toward further decrease in land values in the east by maintaining

high prices for agricultural products in all parts of the country. The extent of that demand and its influence in stimulating production and settlement in the west, and its temporary influence in the east, are shown by the fact that agricultural exports increased from $256,560,972 in 1860 to $361,188,483 in 1870, although by 1870 cotton exportation had not attained the productions which were reached a little later.

The conditions in the south in this decade were radically different from those in the north. As a result of the war, the markets of the south were destroyed, investments in slaves were lost, and land improvements deteriorated. The close of the war found the planters bankrupt, their credit destroyed, and agriculture and all business paralyzed by lack of working capital. Vast areas of land went out of cultivation, the reported acreage of farm land in all the southern states was less in 1870 than in 1860, and the total and average values of land everywhere decreased.

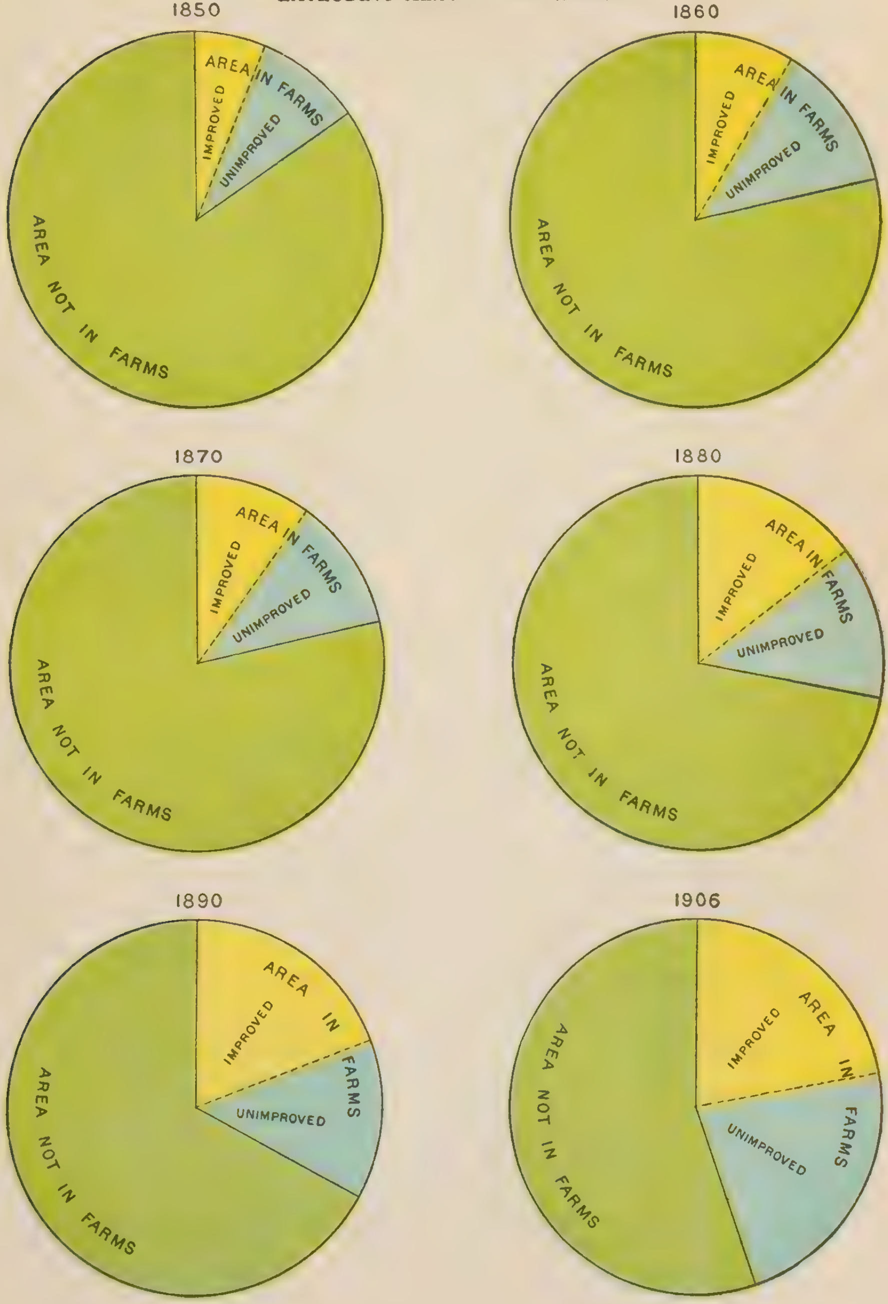
The inflation of the currency during the war affected values expressed in paper money, exaggerating advances and concealing declines. The real change during the decade is therefore better indicated by comparing the gold values of 1870 with those of 1860. The average increase in land values in the north Atlantic, north central, and western divisions was over $5 per acre, while in the two southern divisions there were decreases of from $3 to $5 per acre.

The railroads constructed in the latter part of the decade 1860 to 1870, and in the first half of the succeeding decade, were the principal factors in determining the movement of farm land values in the decade ending with 1880. New markets for agricultural products were opened abroad, and the value of agricultural exports increased from $361,188,483 in 1870 to $685,961,091 in 1880.

The new process of reducing wheat to flour, which was introduced in Minneapolis, Minn., in the early seventies, exerted a powerful influence in opening the spring wheat section of the northwest to settlement. By the new process the flour produced from the hard spring wheat of the northwest was as white as any, and being richer in gluten, it soon commanded a higher price than flour made from winter

RELATIVE PROPORTION OF IMPROVED AND UNIMPROVED AREA IN FARMS TO THE TOTAL AREA OF THE UNITED STATES 1850 TO 1906

EXCLUDING ALASKA AND HAWAII



wheat. Consequently the price of northern spring wheat advanced, greatly stimulating the wheat raising industry and increasing the profits of farming in Minnesota and the Dakotas.

With the readjustment which took place during this decade in the labor conditions of the south, agricultural operations in that section began to assume their old proportions. The increased demand for cotton resulted in a great movement of population from the south and elsewhere to the new cotton lands of Texas and the southwest. Large areas were settled, and land values advanced there as in the south and west.

The growing European demand for American beef, and the increasing consumption of wool in American factories, encouraged the keeping of live stock on the public domain of the west, and especially in Texas. The cost of transporting agricultural products from the west to the seaboard constantly decreased, and the competition between the cheap, fertile prairies of the west and the less productive lands of the east became very apparent. The grain raising sections of the east suffered most, and land values declined there, while in the west they greatly increased.

During the decade 1880 to 1890 there was continued development of all the factors which, in the preceding ten years, had caused land values to advance in the west and south and to decline in the east. Thousands of miles of railroad were constructed and freight charges were constantly reduced. The introduction of new farming machinery cheapened production in the west, and land values rose generally there and in the south, but showed a continued tendency to decline in the east. The introduction of refrigerator cars, about 1878, rendered dairying in the west more profitable by furnishing the means of marketing the produce in good condition in the east. The local monopoly of eastern dairy markets was broken, and the value of grazing land in New York and in New England declined as that of wheat growing land had done in the preceding decade.

While the introduction of refrigerator processes had a depressing effect upon land values in the old dairy sections of the east, it proved a powerful factor in increasing values all through the central and far west. It assisted in opening

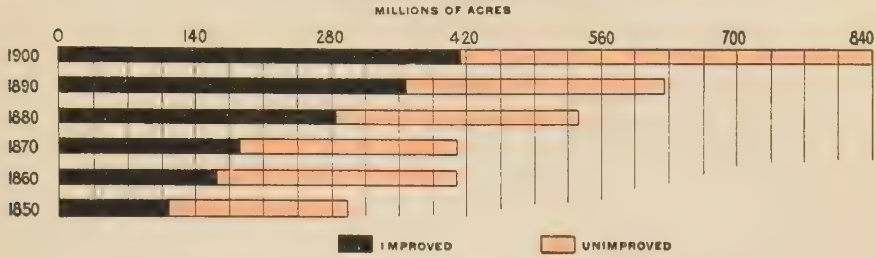
new markets in Europe for American meat, and this stimulated cattle interests in the far west and in the corn growing and cattle and hog raising sections of the central west. The great demand for wheat in Europe in the early eighties and the continuously increasing demand for cotton combined to give to land everywhere, except in the north Atlantic states, values in excess of those reported in 1880.

For a considerable portion of the decade 1890 to 1900, land values were depressed in all parts of the country by the low prices of wheat, cotton, and other staple agricultural products. These low prices checked for a time the advance of values in the west and south, and still further depressed values in the north Atlantic states; but a general upward movement in prices in the latter portion of the decade checked the decline of land values in the older sections, and the tendency to advance again became dominant in the newer states. The average value of farm land in the south central and western states was less than it was ten years before. This was due, not to a decline in land values, but to the inclusion in farms of vast areas of cheap land formerly a part of the public domain.

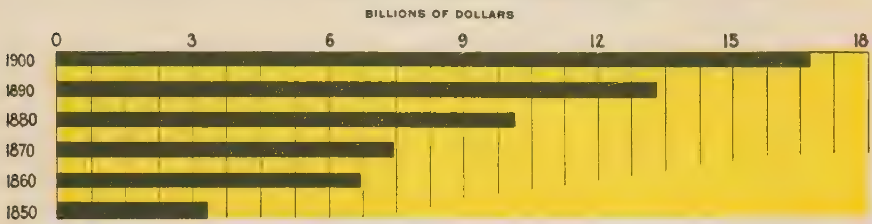
In certain sections of Florida and California, and near the great cities of the east and the central west, where market gardening and fruit growing have attained considerable proportions, there was a general advance in values, although outside of these sections the tendency was in the opposite direction. The financial depression of 1894, like that of 1873, lessened the demand for labor in cities and towns, discouraged the movement of population from farm to town, and resulted in an increase over the preceding decade in the number of farms and the acreage of farm land opened.

The year 1850 practically marks the close of the period in which the only farm implements and machinery, other than the wagon, cart, and cotton gin, were those which, for want of a better designation, may be called implements of hand production. The old cast iron plows were in general use. Grass was mowed with the scythe, and grain was cut with the sickle or cradle and thrashed with the flail. The cost of the simple farm machinery then in use was relatively

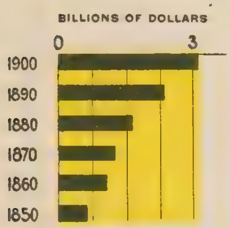
TOTAL NUMBER OF IMPROVED AND UNIMPROVED ACRES IN FARMS, 1850 TO 1900



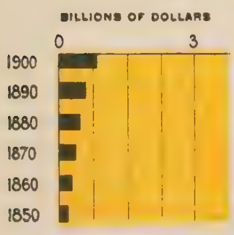
VALUE OF FARM LAND WITH IMPROVEMENTS, 1850 TO 1900



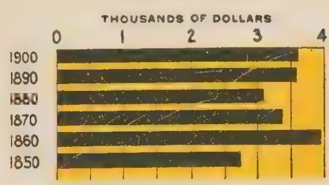
VALUE OF LIVE STOCK ON FARMS, 1850 TO 1900



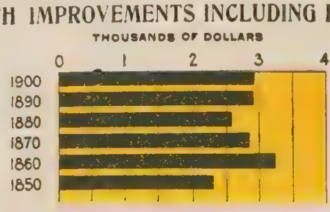
VALUE OF IMPLEMENTS AND MACHINERY ON FARMS, 1850 TO 1900



AVERAGE VALUE PER FARM OF ALL FARM PROPERTY 1850 TO 1900



AVERAGE VALUE PER FARM OF FARM LAND WITH IMPROVEMENTS INCLUDING BUILDINGS, 1850 TO 1900



much higher than at the present time. The last half century has witnessed a revolution in agricultural methods, and the new implements and machines introduced would require more than a page to catalogue.

For the United States the value of machinery per acre of farm land has increased since 1850 from $0.52 to $0.90, or nearly 80 per cent, and since 1880 from $0.76 to $0.90, or about 20 per cent.

The number of acres of leading crops per male worker steadily increased, while the number per working animal was substantially the same in 1900 as in 1880. The increase in the productiveness of man's labor, therefore, is secured by the increased utilization of the power of the horse and the mule in driving farm machinery.

About one half of the 494 buffaloes reported in June, 1900, were "cattaloes," a cross between the domestic cow and the buffalo bull. Both cattaloes and buffaloes are raised on farms as a business. Ostrich raising represents the beginning of an industry which will doubtless become extensive and profitable. The dogs in Alaska were used in agriculture, while those in Tennessee belonged to a farm where such animals were raised for sale.

The total value of the live stock on farms and ranges in the United States, June 1, 1900, was $3,078,050,041, or 15.0 per cent of $20,514,001,838, the reported value of all farm property. Of the live stock value, domestic animals, worth $2,981,722,945, constituted 96.9 per cent; poultry, worth $85,794,996, 2.8 per cent; bees, worth $10,186,513, 0.3 per cent; and special live stock, worth $345,587, barely one hundredth of 1 per cent.

The average value of live stock to a farm in 1900, for all the states and territories and for the different classes of farms, for the United States was $536. In the western division it was $1,512, or nearly three times that for the United States; in the north central, $718; in the north Atlantic, $473; in the south central, $372; and in the south Atlantic, $202. According to this test the importance of live stock in agriculture was greatest in the western division. When the average value of live stock per acre of farm land is considered, a different

result is obtained. For the United States this average was \$3.66. The highest average, \$4.97, was in the north central division; in the North Atlantic it was \$4.90; in the western, \$3.92; in the south central, \$2.35; in the south Atlantic, \$1.86; and in Alaska and Hawaii, \$0.99. The average size of farms in the north Atlantic division was 96.5 acres; in the western, 386.1 acres, or more than four times as great.

The average value of live stock per farm in the north central and western divisions shows an almost continuous increase from 1850 to 1900, while in the south Atlantic division, there was a steady decrease from 1860 to 1900.

The value of live stock in 1900 was greatest in Iowa, being \$278,830,096; Texas ranked second with \$240,576,955; Illinois, third with \$193,758,037; Kansas, fourth with \$190,956,936; and Missouri, fifth with \$160,540,004. The averages per farm in these states were, for Iowa, \$1,220; Texas, \$683: Illinois, \$734; Kansas, \$1,103; and Missouri, \$564. A number of states and territories in which the public domain is extensively used, reported much higher averages per farm.

The south central since 1860, and western since 1850, are the only divisions in which the number of farms increased at a more rapid rate in each decade than the total number of farms in the United States, and the north Atlantic is the only one in which the reverse condition prevailed in each decade.

The great increases since 1850 in the north central, western, and south central divisions draw attention to the fact that the center of agriculture, so far as it can be measured by the number of farms, has for the last half century been moving steadily to the west and south—westward from 1850 until the close of the civil war, and since then to the south and west.

All the various social and industrial changes of the last half century have some features in common. The center of the number of farms, that of the value of farm property, and that of the value of the products of manufactures have all moved westward for a century. The movement of the center of population has been almost due west, inclining a very little to the north; so also has the movement of the cen-

ter of value of manufactured products. In agriculture the movements are different. The center of the number of farms moved west from 1850 to 1860, and thereafter moved continuously to the southwest, forming an arc instead of a straight line. The southward movement is due largely to the subdivision of the old plantations of the south into small holdings, a change which has been going on continuously since 1860.

The center of the number of acres of farm land moved north from 1850 to 1890 and then showed a southward tendency, reflecting the addition of great areas of farm land in Texas, Indian Territory, and Oklahoma.

The center of the value of farm property moved southward before the war, then moved northward, reflecting the destructive results of that conflict upon southern farm values. It later resumed a southward trend, though only to a limited extent. The westward movement of the center of production of corn has fluctuated somewhat from decade to decade between north and south, but, on the whole, has shown a tendency to move due westward with population. The movement in wheat has shown similar inclination, but that in oats has exhibited a marked tendency toward the north along with its westward course.

The center of the number of farms has moved farther westward than the center of population, so also has every other agricultural center, as well as the center of manufactures. The greatest westward movement has been that of wheat—13° 00′ 34″, or more than twice that of population or of manufactures and nearly twice that of the number of farms.

The position of the center of gross farm income was calculated for the year 1899 only, as the reports of the value of farm products for the preceding census years were so unreliable as to make calculations of centers for those years of little practical value. The center of the value of farm products is computed upon the values of the products not fed to live stock, thus giving an exhibit of the center of gross farm income. This center was located at 39° 18′ 47″ north latitude, and 90° 33′ 10″ west longitude, in Greene county, Ill., about 50 miles north northwest of St. Louis. This is farther

north than the center of the number of farms or of the acres of farm land, but a little south of the center of the area of improved farm land, and of that of the production of corn, wheat, and oats. The value of the cotton produced in the southern states brings the center of gross farm income south of that of the combined cereals, which is located west of the center of the number of farms, but east of that of the acres of farm land.

The latitude of the center of cotton production, also, was calculated for the year 1900 only, and was found to be 32° 55′ 14″ north, or only a little more than 2′ distant from the median point. Its longitude was 89° 49′ 25″ west, which differs about 29′ from that of the median point. The approximate location of this center was in Holmes county, 45 miles north northeast from Jackson, Mississippi.

THE TREND OF MODERN AGRICULTURE IN THE UNITED STATES.

BY GEORGE WILLIAM HILL.

[George William Hill, editor of the publications of the United States department of agriculture; born St. Peter's Port, Guernsey, C. I., December 25, 1865: educated in France; for several years as editor of the publications of the department of agriculture he has been an important factor in making them the most valuable helps to the farmer issued by any government.]

It is difficult to imagine more extensive changes than those which occurred in the agricultural industry about the middle of this century. The transition from days of scythe, sickle, and flail to those of mower, reaper, and thrasher; the practical obliteration of distance by modern facilities of transportation and the consequent settlement of the then far western states and territories; the extension of territory resulting from the Mexican war and the widespread influence of the California gold discoveries; the expansion of mining in the west; the "striking oil;" the changes following the Civil war; the influences of the era of industrial activity and speculation to which these several causes gave rise; the marvelous increase in foreign immigration; and, finally, the application of steam to ocean transportation and the rapid development of our foreign export trade, seventy five per cent of which consisted of agricultural products, all these combined to effect changes amounting to a positive transformation, and yet these far reaching influences may almost be said to have had their origin and chief development in the comparatively short period of twenty five years from 1845 to 1870. In no single branch of our industrial life were the effects of these great movements so widely and strongly manifested as in that of agriculture.

Inventive genius, so conspicuous in the improvement of agricultural implements and machinery during this period, multiplied the producing power of the agricultural worker until the laborer of 1870 was able to produce as much as a score of his fellows of 1845. The substitution of the railroad

for the primitive means of transportation, which had satisfied the people in the first half of the century, supplemented by homestead laws and the railroad land grants, practically opened up a new country, and in twenty years (1850 to 1870) one hundred and ten million acres were added to the agricultural domain in the west and southwest, mainly of a fertility unsurpassed by any and equalled in but few portions of the farm area of 1850, while during the same period the number of farms in this vast terrtiory increased by nearly one million. In the same period also, making due allowance for difference in value of currency, the increase in value of these farm lands, with fences and buildings, was, in round numbers, over two thousand seven hundred million dollars, of implements and machinery eighty four million dollars, and of live stock four hundred and six million dollars, an aggregate addition to the agricultural wealth of the country of three thousand one hundred and ninety million dollars, without taking any account of the increase in annual production.

In this enumeration only those sections of the country affected by influences tending to expansion and development have been considered; namely, those states and territories included according to the eleventh census classification, in the divisions known as north central, south central, and western, as follows: North central—Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, the Dakotas (then Dakota territory), Nebraska, and Kansas.

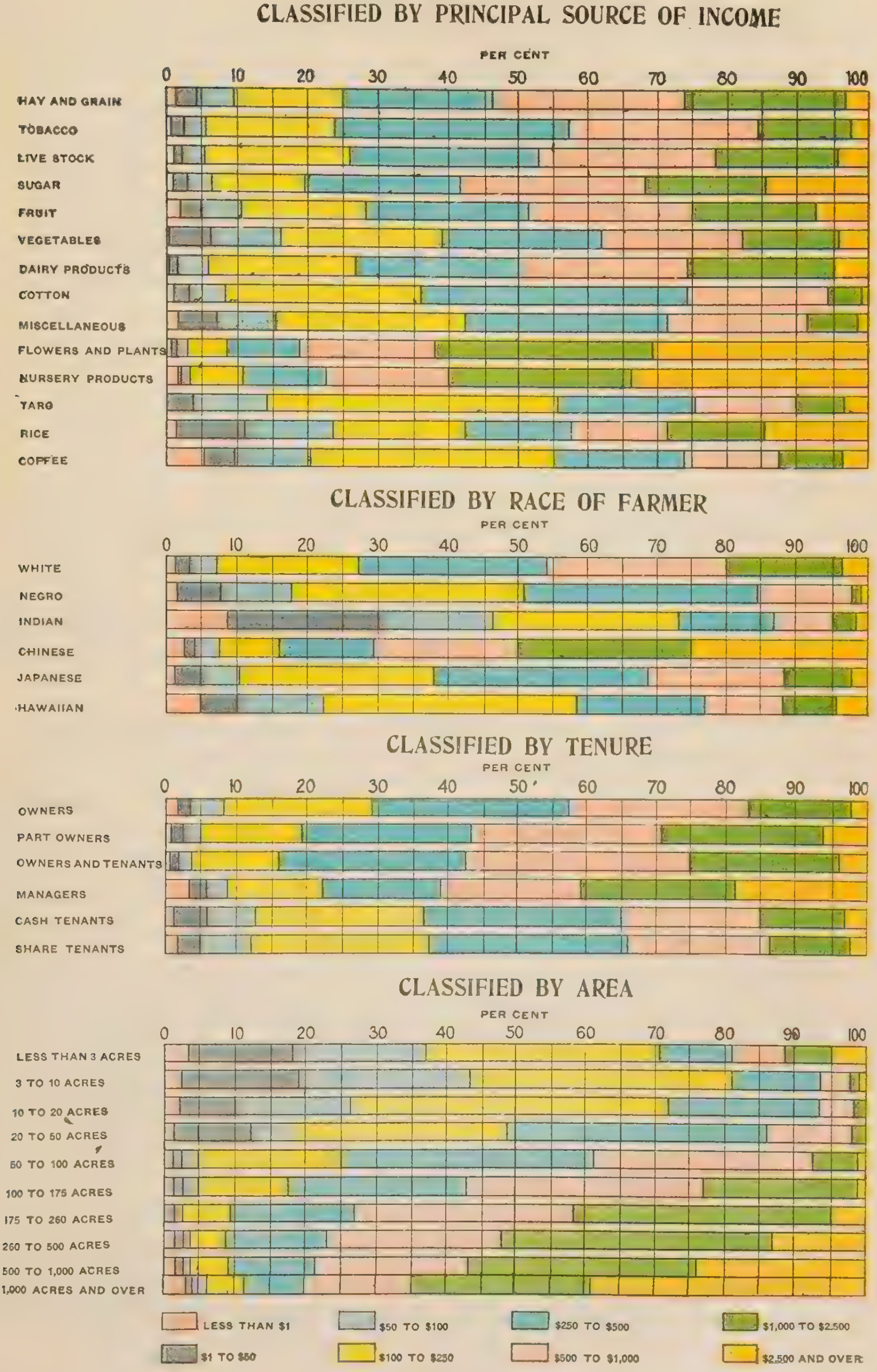
South central—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, and Arkansas.

Western—New Mexico, Utah, Nevada, Washington, Oregon, and California.

The conditions prevailing in the north Atlantic and south Atlantic divisions differed so widely from the foregoing that it is necessary to consider them separately.

Farm values in the north Atlantic division (comprising the whole of New England, New York, New Jersey, and Pennsylvania) showed a considerable increase during the period from 1850 to 1870, but this was not due, as in the other divisions, to the addition of new and hitherto unexplored territory, but rather to the proximity of farm areas already

PERCENTAGES OF THE NUMBER OF FARMS OF SPECIFIED INCOMES



occupied to rapidly developing industrial centers and to the wonderful increase in the urban population of the region. During the twenty years only a small fraction, over thirteen per cent, was added to the total farm area of the north Atlantic division, and this increase was almost entirely in the states of Maine, New York, and Pennsylvania, the increase in New Hampshire, Vermont, and New Jersey being insignificant; Massachusetts, Rhode Island, and Connecticut showing an actual decrease. In these latter states there was an even greater decrease in the improved than in the unimproved farm area. With the exception of Massachusetts and Rhode Island, however, all show an increase in the number of farms, while, as before stated, there was an increase in farm values which aggregated, for the whole division, in lands, fences, and buildings, one thousand seventy two million dollars, in implements and machinery thirty five million dollars, and in live stock, one hundred and fifty five million dollars; an increase of seventy five per cent in values by comparison with an increase in total farm area of thirteen per cent, and in the area of unimproved farm lands of twenty one per cent.

In the south Atlantic division, comprising Delaware, Maryland, Virginia (which in the censuses of 1850 and 1860 embraced West Virginia) North Carolina, South Carolina, Georgia, Florida, and the District of Columbia we find conditions varying materially from those of the other divisions. With a great increase in the number of farms, there was a slight decrease in the aggregate farm area of this division, mainly in the Carolinas; the improved area was practically the same, about thirty million acres, and the increase in farm values aggregated in lands, fences, and buildings, thirty four million dollars, and in live stock five and one half million dollars, but as an offset, there was a decrease of four and one half million dollars in farm implements and machinery, resulting in an aggregate increase of barely thirty five million dollars. This want of progress was not the result of a continuous downward movement, but was wholly due to the enormous decline in both farm areas and values during the decade from 1860 to 1870, consequent upon the civil war,

and succeeding a period (1850–1860) of almost equally remarkable increase.

In this division the farm area had increased from ninety three million acres in 1850 to one hundred and six million acres in 1860 and the total number of farms showed an increase from two hundred and forty eight thousand one hundred and ninety six to three hundred and one thousand nine hundred and forty. In values, the rise from 1850 to 1860 had been even more marked; farm lands, fences, and buildings having increased from five hundred and seventy six million to one thousand and eight million dollars; implements and machinery from twenty four million to thirty four million dollars; and live stock from one hundred and five to one hundred and sixty four million dollars. On the other hand, in the succeeding decade the total farm area had fallen to ninety million acres, and the values as already recorded aggregated only thirty five million dollars over those of 1850. Yet, in spite of this marked reduction in farm area and values, the number of farms had increased during the decade from 301,940 to 374,102, the average size of farms having fallen from 353 to 241 acres. The conclusion is that a very large number of the former slaves had themselves become farmers either on shares or as renters.

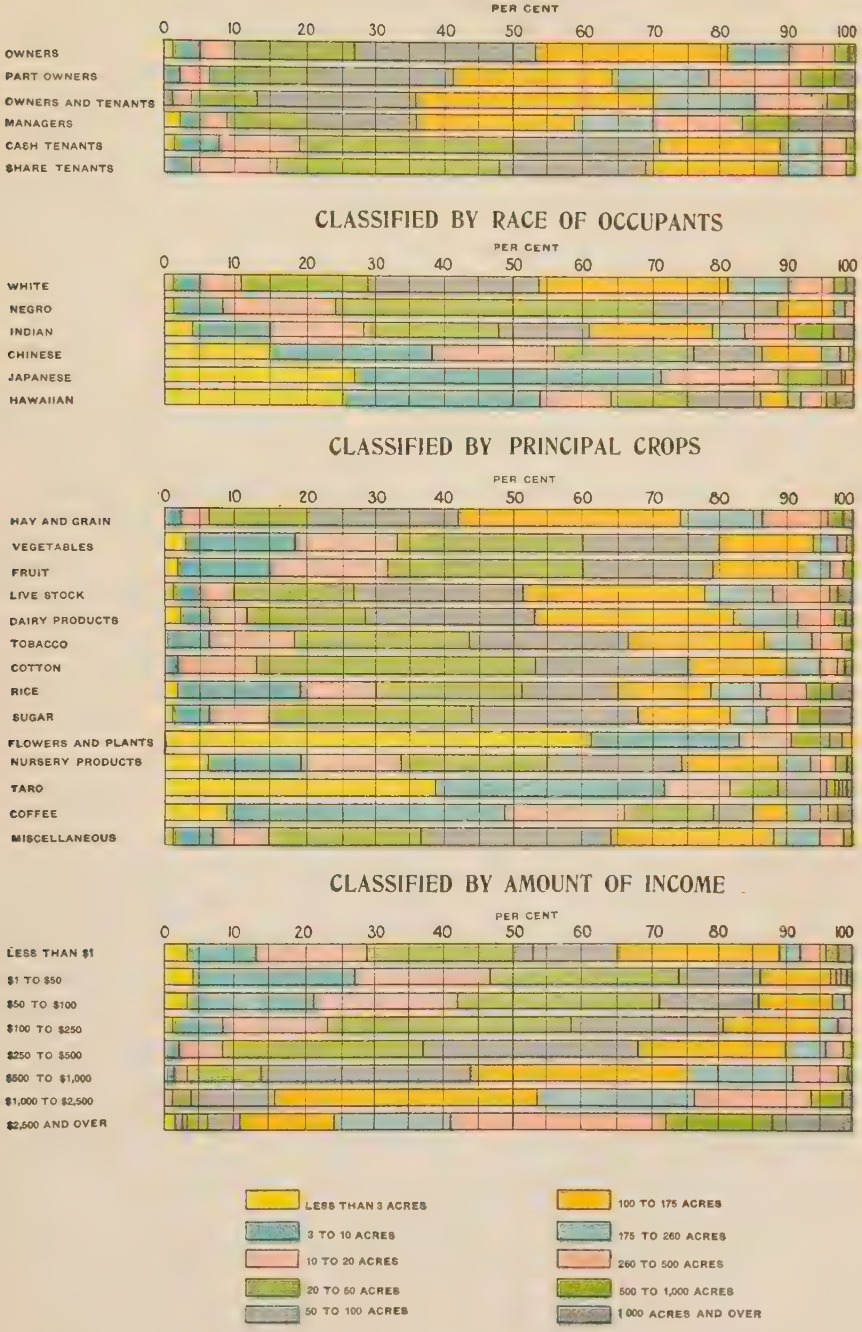
Accompanying these changes in the conditions of the agricultural industry in these various sections of the country, there had been a steady growth in the foreign demand for our agricultural products, while the increasing demands of our home markets are shown very conclusively by the increase in the total population from 23,191,876 in 1850, to 38,558,371 in 1870, over 68 per cent.

It has been necessary to go over these somewhat tedious details in order adequately to appreciate the magnitude of the changes affecting agriculture during the first two decades of the last half of the century, without which no intelligent discussion of the trend of our modern agriculture is possible.

One of the first conclusions to which we are impelled by a consideration of the subject is, that during the transition the farmer had been rather a passive than an active factor in the

PROPORTION OF THE NUMBER OF FARMS OF SPECIFIED AREAS

CLASSIFIED BY TENURE



agricultural development of the period, being influenced to a very great extent by extraneous circumstances beyond his control; nor was this fact due solely to the potency of the circumstances themselves. A marked change had taken place in the character of the farming class; foreign immigration had greatly increased, and many foreigners who had been mere laborers in Europe, taking advantage of the inducements offered settlers in the western states and territories, had become farmers in America. Many of the most intelligent, energetic, and ambitious of the younger generation of farmers in the Atlantic states had been either lured away altogether from farm life by the attractive inducements and opportunities of acquiring wealth afforded by the wonderful growth and activity of industrial life in those states, or had succumbed to the fever of western expansion and had taken up new lands or embarked in other and more congenial money making enterprises in new sections.

In the south the great increase in the number of farms spoke of a transition in many cases from slave to tenant farming, while the planters themselves were but slowly recovering from the disasters of the civil war. In the west and south, at least, the question of the hour was how to secure present subsistence, while a certain restless uncertainty as to the future characterized the farming community generally. Hence, careless farming, and apparently reckless indifference to the future, as manifested in the treatment of the soil and often in a tendency to trust too exclusively to some one staple crop; oftentimes this inefficient farming was due to excess of land and deficiency of capital. In many sections of the country the farmer was not seeking to build up a permanent home, but was constantly looking for a purchaser, with a view either to exploiting new fields, or perhaps, to giving up farming altogether and joining the ranks of the middlemen or the speculators. Rates of interest were high, and capital tempted by the larger profits offered in commercial and industrial enterprises was not easily obtainable for farming pursuits. In a word, the period has been one of transition, with all its advantages, and the spirit of speculation and of "booms" permeated all classes, including the agricultural, which was

largely swayed by, rather than controlling, the circumstances that surrounded it.

The ill effects of unsystematic effort, of reckless farming, and of inadequate capital were largely and fortunately discounted for a time by the rapidly increasing demands of the home and foreign markets, and from 1870 to 1880 we find a great material development in agriculture, the growth of the cattle industry especially being almost phenomenal under the favoring conditions of free and unlimited range in the far west and of rapidly increasing demand abroad.

Gradually and surely, however, warning notes were sounded. The development of ocean transportation which had afforded us an extension of foreign markets, continued in all directions until it developed foreign competition, and, in due time, Russia, India, and Argentina, confronted the United States in the foreign wheat markets. The energy and intelligence of other countries, aided by dishonest practices in our own country, destroyed our growing dairy export trade, or at least relegated our dairy products to a very low place in the world's markets. Australia, New Zealand, and Argentina began to loom up as possible rivals in animal production. At home erstwhile fertile soils began to show signs of exhaustion, and finally a day came when the possibility that almost all the lands in the country available for agriculture would be taken up ere the century closed, began to be seriously discussed.

Reduced prices for many of his products and reduced yields in many of his crops taught the farmer some useful lessons, chief among which were the unprofitableness of haphazard farming, the danger of trusting almost exclusively to one staple crop and the necessity for judicious diversification, the value of manure, the need of well balanced rations in feeding, and the importance of breeding and selection.

At the same time other influences were at work which had a marked effect upon the general character of our farming community. Foreign farmers, or at least their children and successors, had undergone a process of intellectual development which we like to describe as becoming Americanized, and the opportunities for rapid acquisition of wealth in other

industries had diminished, so that the attractions to the more intelligent and ambitious young farmers to leave the farm were less numerous. Thanks to these circumstances the farmer of to-day is rapidly becoming a thinker, a reader, and a student, convinced that knowledge is power and determined to acquire that knowledge so that he may exercise an intelligent and influential part in the control of his own destinies. This determination really supplies the key to the trend of modern agriculture.

Chief among the influences which have aided to bring about this change in the farmer himself must be reckoned the establishment in 1862 of a department of agriculture in the national government and the passage of the agricultural college act, approved July 2, of the same year.

This new department was the development from an humble beginning which originated in the United States patent office in 1837. Commissioner of patents, Hon. Mr. Ellsworth, undertook the collection, mainly through United States consuls abroad, of useful seeds, the distribution of which, in the absence of any appropriation therefor, was largely effected under the franks of members of congress. From this small beginning there grew first a division of agriculture in the patent office, and next a department under an independent commissioner, which became in 1889, a full executive department under the control of a secretary and member of the president's cabinet.

To the work of this department more than to any other one cause, perhaps, is due whatever ability is possessed by the farmer of to-day to meet the many difficulties that confront him. Not only has the department, with its magnificent corps of scientific workers, been the leader in the great work of making "science the handmaid of agriculture" but it has, through its important administrative work, greatly furthered our agricultural interests at home and abroad.

The introduction of many valuable seeds, plants, and trees, such as sorghum, the sugar beet, the navel orange, and many others, including some of the most valuable varieties of our cereals, has done much to efface the stigma attaching to a great deal of the free seed distribution. In addition

there is the work of the department in developing through its division of chemistry our domestic sugar production, the practical results of its investigations in plant pathology and the discovery of efficient remedies for many of the most destructive plant diseases. In the study of and discoveries concerning insects injurious to agriculture, the entomologists of the United States department of agriculture are concededly in the van, no country excepted; the practical saving from destruction of the orange industry of California by the successful introduction of a parasite to prey upon the scale insect is a notable example of their services to agriculture. The investigation of animal diseases in the bureau of animal industry of this department has been of infinite service to the cattle growing interests. The discovery of the curious manner in which the disease commonly known as Texas fever is communicated by ticks; the determination of the hog cholera bacillus and the application of inoculation in mitigating its attacks; the discovery, preparation, and distribution of blackleg vaccine; of tuberculin for determining the presence or otherwise of tuberculosis in cows;—these are some samples of the bureau's scientific work, while in its administrative work may be cited its wonderful struggle with and final control and complete repression of contagious pleuro pneumonia; its control of cattle infected with Texas fever and the protection afforded by it to the channels of the cattle trade at home and abroad; its cattle and meat inspection, including the microscopic inspection of hog meat and its efficient supervision of the cattle carrying ocean steamers;—all of which, or, indeed, any one of which, has already saved the country in actual money return more than enough to pay the entire expenses of the department during the past ten years. To this department are due the important discoveries of the division of soils which have called a halt in the injudicious and wasteful use of water in sections where irrigation is practiced and where every drop of water is precious. Statistical investigations were undertaken by the new department from the beginning and have been continuously maintained. These have covered all branches of agricultural economics, and seek to place at the disposal of the farmers information

for which they would otherwise be dependent upon commercial channels, which, being controlled by those whose interest it is to buy the farmers' products as cheaply as possible in order to sell them subsequently as dearly as possible, could hardly be expected to serve him always impartially. These investigations have been especially active of late years in regard to foreign markets for American agricultural products. Almost all parts of the world have been visited in recent years by the explorers of the department, seeking new and economically useful plants, trees, and seeds, that may be advantageously introduced into our own country. Such are a few of the many services of permanent, practical benefit to the farmer rendered by the United States department of agriculture.

It is true that very many farmers are still ignorant of or indifferent to the work of their special department in the national government, but it has not been possible for all this work to be accomplished without arousing the attention and enlisting the interest and sympathy of hundreds and thousands of them. That such is the case, is amply testified, indeed, by the fact that the number of its publications, through which the results of its work and investigations are made known to the public, has increased from seventy five in 1890, aggregating over 2,000,000 copies, to six hundred and three in 1899, aggregating over 7,000,000 copies.

Only a short time ago in answer to certain inquiries the secretary of agriculture, James Wilson, replied that during the barely three years of his administration there had been issued from his department over one thousand five hundred different publications aggregating twenty million copies, and yet it had been found impossible to supply the legitimate demands for information. One can hardly, in the face of such figures, hesitate to conclude that the trend of modern agriculture in the United States is an intellectual one.

But step by step, though along different lines, there has been the onward movement initiated, as previously stated, by the act establishing the agricultural and mechanical colleges, the purpose of which is thus stated by the originator of the bill, the Hon. Justin S. Morrill, of Vermont, then chair-

man of the committee on agriculture in the house of representatives:

"The bill proposes to establish at least one college in every state upon a sure and perpetual foundation, acceptable to all, but especially to the sons of toil, where all the needful sciences for the practical avocations of life shall be taught; where neither the higher grades of classical studies nor that military drill our country now so highly appreciates will be ignored, and where agriculture, the foundation of all present and future prosperity may look for troops of earnest friends, studying its familiar and recondite economics, and at last elevating it to that higher level where it may fearlessly invoke comparison with the most advanced standards of the world. The bill fixes the leading objects, but, properly, as I think, leaves to the states considerable latitude in carrying out the practical details."

Under this act ten million acres of the public lands have been awarded to the several states to furnish endowments for these colleges, which are coming to be generally known as "agricultural colleges," the results of a policy which seems to tend more and more to instruction in the sciences especially relating to agriculture. These colleges exist in every state and territory of the union, and the liberal endowment mentioned above has been further supplemented with an allowance to each from the national treasury of twenty five thousand dollars annually.

The number of persons in the faculties of the colleges of agriculture and mechanic arts having charge of preparatory classes and collegiate and special classes was 2,461, about one sixth of this number being engaged with the preparatory classes. In the other departments the faculties aggregated 1,141, making a grand total of 3,602 persons in the faculties of the land grant institutions. The students in 1903 were as follows: (1) By classes: Preparatory, 8,801; collegiate classes, 19,161; short course or special, 7,999; postgraduate, 607; other departments, 16,760; total, 52,489. (2) By courses: Four year.—Agriculture, 3,146; horticulture, 539; household economy, 873; mechanical engineering, 4,475; civil engineering, 2,587; electrical engineering, 2,116; mining engineering,

955; chemical engineering, 188; architecture, 182. Shorter.—Agriculture, 5,505; dairying, 867; horticulture, 367; veterinary science, 811; military tactics, 16,316. The graduates in 1903 were 4,524, and since the organization of these institutions, 53,252.

The aggregate value of the permanent funds and equipment of these colleges in 1903 was estimated to be $69,778,463.25; their income, exclusive of the funds received from the United States for agricultural experiment stations ($719,999.50), was $9,248,378.40; the value of additions to their permanent endowment and equipment, $2,743,683.38.

Supplementing these institutions, we now have, again through the liberality of the national government, state experiment stations for original scientific investigations in the service of agriculture. These are attached to the colleges, very often under the same direction, and endowed under the act of March 3, 1888, with an annual income of fifteen thousand dollars each.

These institutions have, since their establishment, undertaken investigations along almost all lines of practical husbandry, and have contributed most of all, perhaps, to the solution of questions pertaining to fertilizing, dairying, and feeding. In many cases important work has been carried on by them in co-operation with the United States department of agriculture. If, as in the case of the department, we seek to gauge the avidity of the farmers for information by the demand for their publications, we find that the experiment station publications in 1903 aggregated 450 reports and bulletins. Moreover, many of the stations issue press bulletins, which are widely reproduced in the agricultural and country papers, and station officers contribute many articles on special topics to agricultural and scientific journals.

There are in the United States forty eight experiment stations which receive the appropriation provided for by act of congress.

So much for the influence upon the trend of modern agriculture of agencies due to the national government. But state governments also have lent their influence in the same direction, as witness the commissioners of agriculture or state

boards of agriculture or other official organizations, such as the farmers' institutes, by which state governments seek to benefit agriculture.

Encouraging, however, as may be these evidences of interest on the part of the government, both national and state, in this most important of all our industries, perhaps the most encouraging feature in our modern agricultural development is the development of the farmer himself, and the gratifying activity which he is manifesting in the work of self culture and intellectual progress.

From the earliest times, going back at least to colonial days, there have been agricultural and horticultural associations and societies seeking to benefit the farmer by continued efforts in collecting and diffusing information in relation to his calling, but there has never been a time when these and kindred organizations have displayed so much activity as in the past twenty years. The annual meetings, at which officers are elected and the business of the associations is disposed of, have been made the occasion for frequent and full discussions of the subjects their members are most interested in, and oftentimes of late years, advantage has been taken of their occurrence, to secure the presence and counsel of men of wide experience and recognized success in their several lines of farming. From these meetings of live stock growers, dairymen, horticulturists, and others, have sprung another class of gatherings, not confined to members of any organization, but appealing to farmers generally, and open for the discussion of all topics bearing upon farming in all its branches. These meetings, known as "farmers' institutes," have become common in a majority of states, in many of which they have secured official recognition and are organized under the general direction of a superintendent, who is a state official and who has at his disposal a fund from which to pay the expenses of a corps of "institute workers" made up mostly of practical, experienced farmers. These institutes are sometimes connected with the agricultural colleges, and in all cases they receive the active support of the college professors and the workers in the experiment stations. As far as practicable the services of the scientists in the United States department

of agriculture are made available for these meetings. Some of the institute workers have attained an almost national reputation, and it is no uncommon thing to find their services in demand in half a dozen different states during the winter season.

One of the good effects of agricultural associations is to be found in the establishment of libraries containing the best books on agricultural subjects, and generally including all the publications issued by the national department of agriculture. Of course, every agricultural college and experiment station possesses such a library, and many of the state boards of agriculture have been careful to establish one. In this line of work much has been done by the national grange. One of the latest plans devised to extend library work to the farmer is that of traveling libraries, composed of several collections of useful books, each collection being deposited in turn for a time in some local center for the benefit of the residents in the neighborhood, thus making a comparatively small number of books serve a very large number of people, and reaching many localities which do not usually enjoy library privileges. Reading clubs and reading courses are becoming common in farming districts, and many of the latter embrace a special course of reading on agricultural topics under the direction of some college professor.

The effect of all this is to elevate the "book farmer" from the contemptible place he held in the estimation of the farmers of a past generation. To-day the most intelligent and successful farmers are those who, to energy and experience, add intelligence, and to intelligence, study, and who are able to, and do, appreciate the work of science on behalf of agriculture. On the other hand it has come to be generally recognized that the farmer who neglects study can, rarely, in these days of fierce competition, attain success. On the contrary he will, in the majority of cases, sink to comparative failure or at least attain but very mediocre success. Hence, if on the one hand there was, twenty or thirty years ago, a tendency to depreciate farming which the farmer himself did much to justify, the past twenty five years has witnessed in him a steady improvement which will surely lead, and is, indeed,

already leading, to a higher appreciation of the dignity, the importance, and, we may add, the intellectual requirements of his calling.

That many farmers will and do fail to keep up with the procession, as the slang phrase inelegantly but expressively puts it, is undoubtedly true, as true as it is in every other calling which demands brains and study as conditions of success, and in which are to be found a score or more, often a hundred, mediocrities to one leader. It is easier to find men fit to be captains than men fit to be generals and much easier to find men fitted for the ranks than for captaincies. In this new country circumstances for many years favored even the poor farmer, but that time has passed away, and while the poor farmer in this country may never sink to the level of the European peasant or English farm laborer, he will, it is to be feared, gradually fall to a comparatively low level, very near the plane of subsistence, and will often find it profitable to work for his successful competitor. Moreover, when all available land has been absorbed by private owners, a consummation which cannot long be postponed, there is bound to be a rise in land values. With all available public lands gone and an addition of forty or fifty million people to our present population, such a result will be unavoidable. Then land will be too dear to permit of poor farming, and it will inevitably come under the control of those who can make it pay.

Two questions arise as a result of the foregoing considerations: (1) What are the material evidences of the farmers' intellectual development? and (2) What are the defects in our system, still calling for remedy?

One, and perhaps the chief, evidence of material benefit due to greater intelligence is to be found in the combination of an increased product with greater economy in production. This is especially evident among stock growers and dairymen, horticulturists, truck farmers, and others, specialists in agriculture. In breeding and selection, in systematic and intelligent feeding, many of the stock growers in the United States have no superiors. Cattle are now matured on an average a year or more earlier than was the case twenty

years ago, and scientifically balanced rations make every ounce of feed count. In dairying the progress has been extraordinary. The average product of a dairy herd is probably twice as great as it was twenty years ago, and the quality of the product has improved in almost equal proportions, while on many farms, thanks to an improved system of feeding, twice as many milch cows are kept as formerly. In the production of fruits and vegetables, a care and intelligence prevails among many growers exceeding those practiced by many of our leading manufacturers. The substitution of domestic for imported products has advanced almost as rapidly as the growth in our exports of agricultural products. The use of fertilizers, the saving of barnyard manure, judicious crop rotation, the absence of which was sadly conspicuous in the seventies have been comparatively common in the nineties.

On the whole, then, we are not without many satisfactory evidences of the material benefits to agriculture and to the country at large of the farmers' intellectual development. Still, a decade is but a very short span in the life of a nation and the effects of the latest development in the agricultural world are only beginning to be revealed to us. Much remains to be done and the application of intelligence to farming must be greatly extended in order to elevate this industry to the place rightly belonging to it.

In the average yield per acre of many of our principal crops we are still far behind many of the countries of the old world. Although we lead the world in aggregate wheat production, in yield per acre, we are far behind the most enlightened countries of Europe and stand next in order, and but little above the average attained by the miserable ryot of India or the but lately emancipated serf of Russia. In sugar, wines, fruits, hides, wool, tobacco, and cotton we still import millions of dollars' worth of products which we could certainly produce profitably at home. Though some of the finest cattle in the world are to be seen in our stock yards, there also are to be seen cattle which cannot be sold at a profit to the grower. Though we make millions of pounds of the best butter and cheese in the world, we still expend

time and energy in producing tons of stuff hardly worthy the name of butter. Many a dairy herd still exists where loss on the poor cows offsets profit on the good ones. We still have to build up our reputation in many markets where it has suffered by the unscrupulousness of some of our farmers and shippers. We still have to learn the lesson that the tastes and whims of foreign consumers must be studied and catered to if we are to compete with the intelligent producers of Denmark, Canada, and Australia.

Those who are teachers and leaders in the intellectual development of the farmer must realize that the economics of agriculture demand as much attention and study as does the science of agriculture. To increase the product and reduce the cost of production is not all, we must also be sure to produce that for which there is an available demand. The great educational forces now existing for agriculture, liberally endowed as they are by both national and state governments, must carry intelligent co-operation much further than has yet been reached. Indeed, so much is there yet to be done that, looking forward, some may falter at the magnitude of the task before us, but anyone who has watched the trend of agricultural development and noted the progress made during the past twenty years, especially in the development of the farmer himself, will therein find good grounds for hope and encouragement.

THE EVOLUTION OF REAPING MACHINES.

BY MERRITT FINLEY MILLER.

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Agricultural machinery is a most important factor in the world's progress, and one which has shown a marked development in recent years. In no class of agricultural implements has there been a more marked development than in that for reaping grain. This development has taken centuries, not because of such a great number of stages, but because of the time in which development was almost wholly wanting—a time extending through centuries when the sickle reigned supreme.

The process of reaping is older than written history. Among the remains of the later stone period in Great Britain and on the continent are found implements of flint resembling a rude form of sickle or reaping hook, while bronze sickles occur quite frequently among the remains of the early European inhabitants. Our earliest records give accounts of reaping which was in most cases carried on by means of implements resembling our modern sickle in form, but of crude construction. These earliest records are from Egyptian history. In that favored land, watered and fertilized by the river Nile, we see the early stages of agricultural development. Here grain was sown, trampled into the loose ground by the hoofs of animals, and left to grow from the rich soil where so little care was needed to produce a crop. It is among the early works of this remarkable people that we find the first records of the process called reaping. A tomb at Thebes, probably built 1400 or 1500 B.C., bears a painting which shows the various operations connected with the cultivation and harvesting of grain. After the style of these ancient works of art, the different operations are shown in series in the same

painting. Two men are represented with sickle like implements, cutting the grain somewhat below the heads. They stand side by side and appear to be making the movements simultaneously; behind them a third man, working alone, seems to be gleaning, while others carry the grain to the oxen, which are tramping it out. Other paintings of this time show two distinct modes of reaping. One was to cut low, a handful at a time, and bind into sheaves; the other, which may scarcely be termed reaping, consisted in pulling up the plants by the roots, the heads afterwards being stripped from the stalks by means of a comb or hackle.

These ancient Egyptian sickles varied somewhat in form and material. The earliest form consisted of a slightly curved blade fastened at one end to a straight handle, both iron and bronze being used. Later the toothed sickle appeared, the form approaching more nearly that of the modern sickle.

The ancient Chinese and Japanese used an implement resembling the sickle, and almost the same thing is used by them to-day. The Japanese used also another implement for reaping, which they called "ani-ani." This cut on the principle of scissors, but was inferior to the reaping hook and was abandoned. It is a remarkable fact that these two large and ancient nations still cling to the reaping hook in harvesting their grain.

The implements of the Jewish people resembled closely those of the Egyptians. The sickle was very common, and this, together with the reaping process, is frequently mentioned in the Bible, for instance: "They reap every one his corn in the field," Job 24: 6; and again in Revelation 14: 15, we find "Thrust in thy sickle, and reap."

To Greece the art of agriculture was passed down from the Egyptians. The Romans, too, aided in the development, and considerable advancement was made in the form of implements during Greek and Roman times. Varro describes three modes of cutting the straw as common in Italy. The first was to cut low with a reaping hook a handful at a time; the second, to cut below the heads with a sickle, consisting of a curved stick with a toothed blade attached, and the third, to cut at the middle of the straw.

The manner of gathering differed likewise, the grain sometimes being bound into sheaves, or, when the heads were detached, they were either taken directly to the thrashing floor or placed in storerooms. Among Roman implements we find besides the ordinary form of sickle and reaping hook a small hooked knife resembling a pruning knife, which was used for reaping. It is at this time also that we find the first records of the scythe being used, and although it is not known exactly when it first appeared, the Romans certainly used it, as ancient Roman drawings show. It was crude in form, consisting of a heavy blade on a long straight handle, and was used more for grass than for grain, the sickle remaining preeminently the reaping implement. Pliny distinguished between the sickle and the scythe, although both were at that time called "sickles." The shorter one, which resembled the modern form, he termed the Italian sickle, and the longer one with two handles or hand holds, which corresponded to our present scythe, he called the Gallic sickle.

After Roman times agriculture began to decline and continued at a very low state for about ten centuries, or almost throughout the middle ages. The pasturing of cattle and sheep in such times of strife and trouble was, of course, preferred to tillage, because animals might be concealed or moved; but few will sow without a reasonable degree of certainty of being able to reap. Some of the operations of tillage were not forgotten, as they were retained by the priests and monks. After about ten centuries agriculture began to revive, and with it was brought back the extensive use of the sickle and scythe.

It would be impracticable, if not impossible, to trace in detail the various changes of form which these implements have undergone in the development since the earliest times, but some of the more important types should be mentioned.

As already stated, the early Egyptian sickle consisted of a slightly curved blade of iron or bronze, attached to a straight handle, while the toothed form of the implement was a later Egyptian type. Soon a greater bow was given the blade, and it began to look more like the modern form. The smooth sickles were heavier than the serrated forms, and were gen-

erally used for cutting near the ground with a chopping motion. The toothed sickle was used to cut the grain nearer the top by means of a drawing motion. As time went on the blade was strengthened by an iron ridge near the back, and finally a steel edge was used. With these improvements both the smooth and serrated sickles reached their most perfect form.

The scythe was a later implement than the sickle, and was an evolution from it. It forms what might be termed the second class of reaping appliances, the sickle being first and the horse reaper last. As has been stated, this second class made its appearance about the time of the Roman era. The first forms had straight handles and were very clumsy and heavy, being used only for cutting grass. A Flemish implement known as the Hainault scythe was a form intermediate between the sickle and scythe, and was used for cutting grain. It consisted of a wide blade about two feet in length, with a handle a little over half as long. It was held in the right hand with the fore finger in a leather loop, the blade being kept in a horizontal position by a flat, projecting part of the handle against the wrist. The grain was gathered by a hook held in the left hand. This was much more efficient than the sickle, but was surpassed by the later forms of the cradle scythe.

The forms of the scythe varied greatly, particularly in the handle. The blade became lighter as time went on, and the handle passed through various double, forked, and iron forms, to the final crooked wooden pattern. But with this development a new feature appeared, which transformed the scythe into a practical hand reaper. This was the fastening of fingers to the snath to assist in collecting the grain into bunches or gavels. Among the earliest devices of this kind was one which consisted simply of two "twigs of osier put semicircularly into the holes made in the snath, near the blade, in such a manner that one semicircle intersected the other." This, projecting upward on the snath, helped to carry the grain around the scythe so as to leave it in a bunch. About the same time fingers were introduced—first a single pin inserted in a hole in the snath, later a series of three or

four short fingers on a bar which was fastened to the snath in such a way that the fingers extended on a line with the scythe. This form generally had a double snath and a blade much longer than the fingers. In using it the operator cut toward the grain, leaving the cut stalks standing in a fairly well gathered bunch against the standing grain.

With the development of agriculture among the American colonists came an improved form of the cradle scythe. Doubtless all the European types had been brought over by the colonists, and what is termed the American cradle was simply an improvement upon some of these earlier forms. It is impossible to determine just when this implement was invented, but this is of little consequence, as it was doubtless a growth rather than a single invention. It is known to have been in quite common use before the beginning of the nineteenth century, and was rapidly taking the place of the sickle. Professor Brewer, of Yale, in his History of Agriculture in the United States, divides the history into four periods, the second of which extends from the time of the declaration of independence to the introduction of the cast iron plow about fifty years later. Of this period he says:

Many other improved implements came into use during this same fifty years, of which the two most important in connection with American grain growing were the American cradle and the fanning mill for cleaning seed after it was thrashed. The sickle was common, though not in universal use at the time of the American revolution. It was rarely used when the century closed and had ceased entirely as an implement for cutting other cereals than Indian corn before the close of this period.

These statements fix the introduction of the American cradle as somewhere between 1776 and the close of the century.

The American cradle was the culmination of the improvements in hand reaping implements which had begun ages before in the rude stone implements of prehistoric races. Why it should have taken so many centuries to reach its perfect form is a subject for conjecture. Once perfected, it spread rapidly to other countries either in its original form

or in a form modified by foreign manufacturers. To-day it is still used in various parts of Europe, and even in America where conditions make the use of the reaping machine impracticable.

The sickle still has its place even in the most advanced nations, and it is used almost exclusively in some of the least developed countries, especially in the Orient. The scythe also is a necessary implement in the nations most advanced in agricultural methods. But, with the advent of the horse reaper and mower, these crude hand implements ceased to occupy any important place in modern agriculture.

It is a remarkable fact that the operation of reaping should have been carried on for centuries with the sickle and scythe as the only reaping implements. Yet, such was the case, for almost nothing was done toward constructing a reaping machine until near the close of the eighteenth century, and almost one third of the nineteenth century had passed before a practical machine was constructed. For thousands of years the sickle had been the only means of cutting grain, with the exception of the scythe, which came into use in the later centuries. But now a new era was ushered in—an era in which the reaping process was revolutionized and the possibilities of grain growing extended by making the labor of gathering the grain one of the smallest factors connected with the industry. There were a few attempts made toward constructing a reaping machine even during this long period when the sickle held sway, but they were rude affairs and were of little consequence. It is thought, also, that some such machines were in use by the ancients, of which we have no records, but this is only conjecture.

The first mention in history of a reaping machine is one described by Pliny during the first century, as in use in the fields of Gaul. It was not a true reaping machine, but a "header," consisting of a large hollow frame, mounted on two wheels, and set with teeth along its front edge. These teeth caught the heads and tore them off, after which they were raked into the box by an attendant. This machine, like all the early forms, was pushed by an animal yoked behind it. Palladius gives a similar account of the machine, and adds

that "the driver can set the teeth high or low, and that a few goings over the fields will clearly reap it if the ground is smooth." As this mention by Palladius was made in the fourth century, it is probable that some form of the machine was in use for many years, but nothing very practical came of it, and it seems to have been forgotten for centuries.

But now we come to the age when inventors began turning their attention to machines to lighten the labor of harvesting, to a time when competition was becoming more fierce, labor more costly, and any saving of time a gain to civilization. The first of these reaping machines was after the plan of the ancient header of Gaul. A man by the name of Capel Lofft, of Britain, first suggested the idea of a reaping machine, in 1785, probably as a result of the proposal made in 1780, by the Society of Arts, for a premium to be given the author of such an invention. In 1786 or 1787 a machine was constructed by William Pitt, of Pendeford, England, which was in reality a header, but which was constructed on a principle somewhat different from the Lofft and Gallic machines, although doubtless suggested by them. Instead of a row of fixed teeth, a cylinder fitted with rows of comb like teeth was placed horizontally on the front part of the frame and made to revolve by the power transmitted to it from the wheels. As it revolved, the inclined teeth caught the heads and carried them over the cylinder into the box of the machine. The animal was of course attached behind, which was a characteristic method of hitching in these early forms, since it was necessary that the grain should not be trodden upon, and no one had as yet thought of the side cut.

The first machine of importance working on the revolving knife plan was that of Joseph Boyce, of London, also built in 1799, which was the first English machine patented. It had a vertical shaft, to which were fastened a number of blades. This shaft was made to revolve by power transmitted from the wheels on which the machine was mounted. It had no contrivance for gathering grain to the knives or for laying the cut grain in a swath or in gavels.

In 1811 a Mr. Smith, of Deanston, built a machine which he kept improving until 1814, when it performed its work

better than any which had appeared up to that time. It was designed primarily as a mowing machine. It had the rotating cutter principle, and consisted of a framework mounted upon two wheels, bearing an inverted conical drum with a projecting circular knife at its lower and smaller end. This drum was made to revolve by motion transmitted to it by a system of cogs connected with the wheels, thus severing the grain and bearing it to one side into a swath. Two small wheels beneath the drum kept the knife at a proper distance from the ground, and a contrivance was added by which this distance could be increased or decreased. It followed the old plan of having the horses hitched behind the machine.

Nothing further of importance came out until 1820, when Mann, of Roby, constructed his model of a reaping machine. This attracted much attention, but the full sized machine was not constructed until 1822, and, when it did appear, it was so complicated that success was doubtful. He continued to work on the machine, however, until 1832, at which time it could be described as follows: A wheeled frame bearing a polygonal revolving cutter, with a series of revolving rakes for carrying the grain to the swath, and an apparatus for cleaning the rakes. The machine was drawn, and the line of draft, although applied in front, was parallel to the line of motion. The special feature was the twelve sided cutter, which was expected to be more efficient than a circular one. It did not come up to expectation, however, and although used to some extent in the field, it never came into general use.

We now come to one of the most noted inventions in reapers, that of Henry Ogle, a schoolmaster of Remington, whose machine came out in 1822. Ogle was a genius of high order and well deserves the honor bestowed upon him. The machine itself never became popular, but the principle of the cutter together with the reel which he constructed is found incorporated in every successful reaper since that time. He constructed a model of a machine in 1822, but not being a workman himself, he submitted the making of a full sized machine to Thomas and Joseph Brown, of Alnwick, England, who afterwards helped him in his design. Hence the machine

is sometimes spoken of as the Ogle and Brown machine. It resembled the skeleton of a cart with wheels and shafts, the horse walking ahead beside the standing grain and the cutting apparatus extending to the right side. This cutter consisted of a frame whose front bar was of iron armed with rows of teeth three inches long projecting forward. Directly under these lay the cutter, a straight edged knife. There was a reel resembling the modern form, which pushed the grain backward onto a platform situated behind the cutter. This platform if hinged could be used as a dropper; if fixed, the grain could be raked off in gavels. In the words of Mr. Ogle this platform when hinged is lifted till as much corn is collected as will make a sheaf and let fall by a lever upon the frame, when the corn slides off, when it is a little raised again. It was found, however, to answer better when it was put off with a man and a fork toward the horses, as it is easier bound and leaves the stubble clear for the horse to go upon. From the position of the lever a seat was evidently provided for the operator.

Here, then, we have the foreshadowing of the future reaper—the reciprocating knife over stationary fingers, the reel, the platform, and dividers. It was drawn from the front and side and was borne on two wheels, as are all modern machines. To be sure, the dividers and platform had been used before, while Salmon had made a kind of reciprocating knife in 1807; yet the latter was very unlike this, acting more on the principle of the scissors. Ogle should be given the credit for the first reciprocating knife combined with stationary fingers, together with a very happy combination of other lasting features of the reaper; and while the machine never became a great success, owing in a great measure to the disfavor in which reaping machines were held by laborers and to the threats made upon the manufacturer, yet it was the embryo of the modern reaper and holds a prominent place in the development of these machines.

Up to this time no machine had been in any great degree successful in the field. We come now to a machine which was brought into use in considerable numbers and which was used for some time in the field of England and Scotland, some

even being sent to this country. It was invented by Patrick Bell, of Carmyllie, Forfarshire, in 1826, and put in the field in the following year.

After much consideration he constructed an apparatus which he thought would do the work, making his first tests on an artificial field of oats in his workshop. After about two years' experimenting he brought out what has since been known as the Bell reaper. It consisted of a wooden frame mounted on wheels, with a pole extending backward, to which the horses were attached. The cutting apparatus was on a shearing or clipping principle and consisted of thirteen stationary blades about fifteen inches long and about four inches wide at the wider or base end, above which were placed twelve movable blades of about the same size, fastened on pivots so as to be moved back and forth over the stationary ones below, thus giving a motion like to that of so many pairs of shears. The power was communicated to the movable blades by connecting their rear ends with a sliding bar, made to move by an oscillating rod connected with a worm flange on a revolving shaft. A canvas moving on rollers and sloping to the cutters carried the cut grain to one side, where it was left in a continuous, even swath. The machine was also provided with dividers and with a reel much like the modern forms.

This machine, although built on the wrong principle to ever become a great success, was used for many years in various parts of England, or until the introduction of the better machines springing from the inventions of Hussey and McCormick, the two Americans whose machines were made the basis of the wonderful development in harvesting implements which took place within the next fifty years. With the introduction of these American machines there entered a foreign element into English invention, and from this time on the machines of importance were various improvements upon three types—Bell's, Hussey's, and McCormick's.

The Hussey machine consisted of a low frame mounted on two wheels, the larger being the drive wheel which transmitted the motion to a vibrating bar, bearing pointed blades or sections working through slots in iron fingers projecting

forward on the front of the cutter bar. Behind the cutter was placed a platform to receive the cut grain, from which it was raked by a man riding on the machine. The machine was exceedingly simple, and was without reel or any complicated apparatus.

The McCormick machine was somewhat more complicated, but had the same principle of a vibrating knife, excepting that in this case the knife had a serrated edge with only a wavy outline instead of pointed sections as in Hussey's. The fingers also differed somewhat from the Hussey type, and a reel was added to make the cutter more effective, but no place was provided on the machine for the raker, who was compelled to walk. Both machines were drawn, the horses being in front of the machine and beside the standing grain.

It was at the great exhibition of 1851 where such a golden opportunity was given for the display of inventions that a widespread interest became manifest in regard to reaping machinery. This was occasioned chiefly by the appearance of the Hussey and McCormick machines which were entered in competition at this time. In addition to these, a machine was contributed by a Mr. Garrett which, however, was the invention of a man by the name of Tolemache. It possessed the advantage of a side delivery, and the horses were yoked one before the other. Numerous models were exhibited, but these were the three of importance.

The knife in McCormick's machine had a serrated edge with numerous obtuse blades riveted into the bar, forming very obtuse angles, so that it acted as a saw, requiring the aid of a reel to hold the grain against it. Hussey's, on the other hand, had pointed knives which formed very acute angles with the guards, and the cutting was more in the nature of clipping or chopping. It was more likely to choke than McCormick's, and one of the chief objections to it was that it required too fast a pace of the horses to keep it cutting well. Garrett's was inferior to both these machines, and in the trial McCormick won the medal. Not being satisfied with this, Hussey asked for another trial, which took place sometime afterwards and in which his machine carried off the honors over McCormick's.

McCormick's English machine in 1861 differed from the preceding in delivering the grain in gavels rather than in the swath. It was virtually the American self rake. It had a series of revolving vanes, one of which was made to sweep the grain from the platform out of the way of the next round.

Thus we see that the mower advanced in great measure, hand in hand with the reaper, so that it is almost impossible to separate the two in the early stages of development. Later we see that the point at which they did diverge was in the construction of the knife, the reaper taking a toothed edge section and the mower the more rapidly vibrating sickle with the smooth edge sections. At this point it would be well to pause in noting the development of English machines and turn to America, the birthplace of the practical reaper. All the successful English machines at this time were but modified forms of the American machines, so that it is to this country that we must look for the original patterns and the true development of harvesting machines. The crude English machines of the early part of the century set the American inventor thinking, and in due time he laid the foundation upon which the reaping machines both in America and England have since been constructed.

The first patent granted in America for a reaping machine was to Richard French and T. J. Hawkins of New Jersey, May 17, 1803. This is the earliest record that has been found of an effort to build a reaper, but no reliable description of the machine seems to have been preserved. It had three wheels, one of which entered the standing grain, but other information seems to be lacking.

The earlier American inventions were mostly along the lines of grass cutters, but as reapers and mowers were at first so closely related they should be discussed together here. On December 4, 1812, Peter Gaillard, of Lancaster, Pa., was granted a patent for a grass cutting machine, the first of its kind in America, all machines before this time being intended for cutting grain and not grass; thus the idea of mowing grass by horsepower with a machine built solely for that purpose originated in America, although the machine invented by Smith, of Deanston, in 1811, was designed primarily for cut-

ting grass. Gaillard's machine was of little consequence; but on February 13, 1822, Jeremiah Bailey, also of Pennsylvania, took out a patent for a grass cutter, which gained quite a reputation throughout the country. It was on the revolving cutter plan, and consisted of a rectangular frame supported by two large wheels, one being inside the frame and acting as a drive wheel, the motion being transmitted to the rotating cutter through a series of cogs. The cutter was shaped like a low crowned hat, the crown being 3 feet 5 inches in diameter, and the brim about 1 foot wide. This was of wood, with the exception of the knife which formed the edge of the brim. The knife was kept at the proper distance from the ground by a shoe, so arranged that the distance could be increased or diminished at will. The horse walked ahead beside the grass. This was the first mower that met with the slightest success, and it was used to some extent in practical work. It was the first to indicate the principle of a flexible bar by this arrangement for keeping the knife at a uniform distance from the ground.

The next patented invention worthy of notice is one by Samuel Lane, August 8, 1828, for a combined harvester and thrasher. It was ingenious, but too complicated, and was never used with success. It is of interest as being the first attempt at this combination.

The next invention was one of considerable importance, and, although it was built as a reaping machine, its cutting apparatus was an important step in the improvement of both mowers and reapers. The invention was that of William Manning, of New Jersey, patented May 3, 1831. It had two ground wheels fixed to the same axle, from which a frame extended, having a bar attachment held in place by two arms, and provided with teeth six or eight inches in length, extending forward into the grain. A flat bar of iron lay upon this bar, bearing spear shaped cutters sharpened on each of their edges. These were about six inches long, and cut the grain as it was held by the teeth. This was substantially the scalloped sickle, and was Manning's original patent, resembling much the celebrated cutters of Hussey and

McCormick, which afterwards became so important. It had a grain divider, the first on record in America.

Obed Hussey, of Baltimore, Md., patented his world famous machine December 31, 1833. About this time experiments were in progress with a machine invented by Cyrus N. McCormick, of Virginia, which, with some later improvements, was also destined to go down in history as one of the most important machines in the development of reaping machinery. This machine is reported to have been first used in the harvest of 1831, but no patent was taken out until June 21, 1834. These are the two machines which stood out as models for all others that were afterwards successful.

Hussey's machine as patented and first constructed was mounted on two wheels, to the rear and somewhat to the right of which extended a platform with the cutting apparatus on its front edge. This platform was at first supported in the rear by a roller and later a wheel was added at its outer edge. The cutter was the unique part of this machine, and consisted of a series of slotted iron fingers through which vibrated a number of triangular knives fixed to a flat bar. The fingers or guards were seven or eight inches long, with a slot for admitting the knife and were fixed solidly to the front edge of the platform, extending forward into the grain. The knife consisted of a series of triangular plates riveted to a flat iron bar and forming a kind of coarse toothed saw. One end of this saw was attached to a pitman moved by a crank and receiving its motion from the main axle by means of cogs.

McCormick's machine at this time (one year before it was patented) was somewhat more complicated than Hussey's and not quite so substantial. It was drawn by one horse hitched in shafts and walking beside the standing grain. The drive wheel was situated almost directly behind the horse and through a series of cogs gave a reciprocating motion to the cutting knife. This knife was about four and a half feet long, with an edge like a sickle, and worked through wires projecting before it, which held the grain while being cut. Behind this was an apron or platform five or six feet long, made of thin plank, from which the grain was raked by a man walking behind the machine. At the outer end of the platform next

to the grain was a partition consisting of a cloth covered frame, to divide the cut from the uncut grain. There was a reel six or seven feet in diameter and as long as the knife, fastened just over the cutter and made to revolve by a band connected with the main axle.

The machine also had a divider to separate the cut and uncut grain and a large reel to hold the grain against the knife. Thus it is seen that the machine corresponded very closely with the one described as in use in 1833, so that, while the patent was not granted until the next year, McCormick as well as Hussey had his machine at work in the harvest of 1833. However, as was stated before, McCormick's machine was undoubtedly invented prior to this time, as he had a machine which operated in the harvest of 1831. According to McCormick's own statement in his communication filed when seeking for an extension of his patent in 1848, this early machine was essentially the same as that patented in 1834. Be that as it may, it is certain that he had a machine invented in 1831 and that it was tried in that year, but that it was a success is not so evident. Hussey, on the other hand, makes no claim to having invented his machine before 1833.

The most important part about each of these machines is the cutting apparatus, and these being the pioneers in successful cutters they should be examined in detail.

Hussey's cutter is really a novel and surely an original feature of his machine. Although a vibrating knife had been used before, it was not like this, and nothing resembling the slotted fingers had ever been known. These fingers, or guards, were formed of a top and bottom piece, joined at the point near the back, but leaving a slot through which the knife played. They were fixed securely into the bar on the front edge of the platform at intervals of about 3 inches, and extended forward into the grain about 7 or 8 inches. The cutter, or saw, was formed of thin triangular plates of steel (being made from old saw blades in the first machine) which were riveted side by side in a flat bar. They were $4\frac{1}{2}$ inches long and 3 inches wide at the base, but terminating in almost a point. They were sharpened on both edges and beveled from both sides, unlike the present mower sections,

which are beveled from above only. The action, then, was not on the shearing principle, as in Bell's machine, but was rather a chopping or clipping action. The patent specifications state plainly that "the saw teeth shall play clear over the guards both above and below," so that the invention could not have been copied from Bell's shearing plan, as has sometimes been claimed. The doubly beveled sections and closed guard were soon found to be faulty, as the cutters were especially liable to clog. Another feature had considerable to do with the clogging and also increased the draft greatly, i.e., the acute angle which the blade formed with the guard. In order to remedy this difficulty some changes were soon made. The blade was shortened and made more obtuse. About an inch of the edge of each blade near its base was left flat below and beveled only from above, in order to shear the trash and grass which gathered in the back part of the slot, and, lastly, the guard, instead of having a closed slot, was open at the back and upper part, this last modification constituting the principal feature of Hussey's patent of August 7, 1847. As time went on and many inventors applied themselves to the improvement of this form of cutter, more and more of the edge of the blade was left in contact with the guard below, and the blade became more and more obtuse, approaching more nearly the shape of the mower sections of the present day. Thus it is seen that while Hussey's invention contained features vital to the reaper, it had a greater effect upon the development of the mowing machine, and was more strictly a type of mower than of reaper.

McCormick's cutter as first used consisted of a straight blade vibrating between projecting wires which held the grain while being cut. This blade, as the patent specifications say, was "either smooth or with teeth," and very probably the first machines tried had a perfectly smooth blade, which very soon gave place to the serrated form. The arrangement of projecting wires to hold the grain while cutting was also used at first, but later a sort of finger was devised consisting of a strap of iron extending forward over the blade and then bending back under it, leaving an opening at the back part and beneath. These guards were used until 1839. In

1840 the fingers were changed to double closed ones of the Hussey type, but, as in Hussey's machine, this closed finger had a tendency to cause clogging, and was changed for a later style as patented January 31, 1845. In 1841 a change was made in the serrations on the blade, making alternated groups of teeth to point toward each other, so as to incline toward the guards in the reciprocating motion. Then came the modification of the guards, as above mentioned, changing them to spear shaped projections, flattened horizontally. Both these changes were incorporated in the patent of January 31, 1845; also "the curved bearer for supporting the blade," the reversed angle of the blade, the construction of the guards so as to form angular spaces in front of the blade, the combination of bow and dividing iron for supporting the grain, and the position of the reel post on the machine.

In 1852 McCormick adopted the open finger guard of the Hussey type, and made the blade slightly scalloped on the cutting edge. Later the scallops were made more pronounced, finally developing into the obtuse angled serrated section, resembling that used on reapers and binders to-day. It must not be thought, however, that the present forms of guards and sections are Hussey's and McCormick's ideas alone, for they are really the result of improvements made by various individuals on the original Hussey and McCormick inventions. These two men were not left long to themselves, for as soon as the practical form was established other inventors took up the work and by various improvements aided in the development.

As to which of these men should have more credit for originality of invention, or for furthering the development of reaping machines, it is difficult to decide. Many of the principles incorporated in these machines had at least been hinted at before, and whether or not these men knew of such inventions can only be conjectured. Although in that day news did not travel so rapidly, it is very probable that the first idea of vibrating cutters was imported from England, in the remarkable invention of Ogle of 1822. It must be remembered, also, that Manning, in 1831, had used a vibrating cutter with spear shaped knives, and this step was as

great, so far as the invention was concerned, as that taken by either of the men whose machines we have been considering. Ogle also had a platform, so that this was not new. Manning had a divider, while Bell and Ogle both had reels, so that McCormick was not first with that feature. Thus, it is seen that the foundation principles of both machines might have been suggested, at least in part, by early inventors. The fact that both these men made valuable inventions on which the real development of reaping machines has been based, is sufficient to give them places of great honor among the promoters of agricultural progress. It is undoubtedly true that in their later improvements each man was in some measure influenced and aided by the other. Thus, Hussey's knife became more like McCormick's and McCormick's more like Hussey's as time went on. McCormick profited by the Hussey idea of the guards, and Hussey made use of McCormick's principle of balancing the machine on two wheels. Hussey's cutting apparatus was the most unique and probably the most original, while McCormick's tactful combination of so many essential features, whether original or not, did wonders toward furthering the development of harvesting machinery.

Having considered the two foundation machines, we may now notice the various improvements and modifications which have appeared in developing the machines of the present day. The patents and inventions are so numerous, however, that it will be possible to give only the most important, or those containing some essential features of the later machines; and as the mower and reaper were at first often combined in the same machine, some of the earlier patents referring to mowers must also be mentioned. The mower was at first simply the reaper dismantled of its platform and other parts not needed for grass cutting, although separate machines for this purpose were early constructed. As the mower required a higher speed of the knives than the reaper, no successful type of this machine was constructed until a device for accomplishing this end was invented.

Enoch Ambler, of New York, obtained a patent December 23, 1834, about which little can be learned. It is under-

stood, however, that he had the first wrought iron finger bar with steel guards and shoes. There is some difference of opinion as to the worth of this invention, but the finger bar seems to have been somewhat in advance of the times, resembling the later forms of the McCormick and Hussey machines.

Abraham Randall (or Rundell), of New York, April 22, 1835, patented a curious cutting device, consisting of two sickles or cutters with corresponding points to be operated in contrary directions, thus making a double shear cut with each pair of points, the whole acting as a series of double acting shears. It was one of the most important of a number of inventions on this principle which were made in this country and in England, one successful mower, the Danford, being upon this principle. This Randall machine also contained a raking and discharging device, which was among the first attempts at an automatic rake. Up to this time the raking had all been done by hand; but now, after the essential parts of the reaper were worked out, inventors began to endeavor to perfect the machine and to solve the problem of a successful automatic device to remove the grain from the platform.

The early devices for automatically removing the grain from the platform were varied and often crude. It will be remembered that Bell used an endless canvas to lay the grain in a swath at the side, while Crosskill's English modification of McCormick's machine several years later used a number of Archimedian screws to accomplish the same purpose. These and numerous other devices were tried, such as reciprocating bars with pegs to work the grain to one side and rake teeth penetrating a stationary platform below, as in Reed's machine. Finally, among the numerous attempts along this line came that which operated with rakes above a stationary platform, the type from which the self rake was at last developed. Among the first of this class were the single rake type, which raked directly backward with a horizontal motion. Others had a rake fastened to the reel, while some had single rakes sweeping a quadrant platform. Finally came the revolving fans, either on a vertical or an inclined axis, one of which raked the platform. Later the vanes or fans were all

made alike, each being capable of sweeping the platform at the will of the operator.

One of the first patented inventions which sought to deliver the gavels automatically was that of Schnebly, patented in 1833. It had a horizontal endless apron, traveling intermittently and thus delivering the grain in gavels by the side of the machine. In 1838 Cyrenus Wheeler invented a machine with a revolving endless apron to deposit the grain in a box with a sliding bottom which could be opened, thus dropping the grain in gavels. Jonathan Reed patented a machine March 12, 1842, that had a rake beneath the platform with teeth projecting through the slots to remove the grain in gavels. He also introduced a form of cutter which possessed the peculiarity of serrated guards in combination with serrated cutters, but this never seemed practical. Clinton Foster, this same year, April 18, patented a form of rake which swept across the platform as controlled by the operator, and November 20, 1846, Andrew Cook patented a rake which was attached to the reel, forming a revolving reel rake, the first of its class.

A. J. Purviance, of Ohio, May 22, 1849, obtained a patent for constructing the platform separate from the other framework so as to convert the machine into a mower or reaper as required. This was the first practical combined machine, and marked the beginning of the long list of such machines both in America and England. On June 12 of the same year an important patent was taken out by Nelson Platt, which was afterwards assigned to Seymour & Morgan, pioneers in the development of the self rake. It had a self acting rake sweeping over a quadrantal platform and leaving the grain in gavels at the side of the machine. It was the first of the sweep rake system which afterwards became so popular. On June 19 of this year J. J. & H. F. Mann patented a device consisting of endless bands delivering the grain into a receiver from which it was discharged in gavels by an attendant.

This brings the history up to 1850, most inventions of any importance made prior to that date having been mentioned. From this time on inventors by the score began

turning their attention to perfecting the means of delivering the grain, and patents became so numerous that it will be possible in this treatise to mention only those most essential to the development. About this time, as the machines became more and more in demand, companies began to spring up to engage in their manufacture, so that in a few years the industry became of vast importance and the machines came into use throughout the United States and were rapidly introduced into other countries. Within ten years the mower became practically what it is to-day and another decade saw the foundation of the modern binder practically laid.

John H. Manny obtained a patent September 23, 1851, for hanging the cutter bar to the side of a triangular frame so that neither end could sag; also for a forker's stand back of the outer end of the platform. It had sickle edged knives and the cutter could be raised or lowered at will. It could be used as a mower by detaching the platform, but was objected to as being too cumbersome. It was one of the earliest successful combined machines and laid the foundation of the reaper business of Rockford, Ill. R. T. Osgood obtained a patent February 17, 1852, for independent driving and supporting wheels on a common axle carrying a rectangular frame between them on the axle, also providing each drive wheel with ratchet wheel and pawl as used in the mowers of to-day. This was assigned to Cyrenus Wheeler, and, together with others, became one of the base patents of the Cayuga Chief, a very popular machine of that day.

In 1855, J. E. Newcomb obtained a patent for a dropper, which was assigned to J. F. Sieberling, of Ohio, the acknowledged head of the dropper system. The dropper as now used consists of an attachment behind the cutter bar, which holds the grain until enough has been accumulated for a sheaf, when it is lowered and the grain allowed to slide off. The first invention along this line was by Ogle (1822), who had some such arrangement on his machine. Other devices have been used, such as one by Wheeler, in 1838, which delivered the grain by a canvas into a box, from which it was dropped. The most improved form, however, consists of a number of slats fastened to the rear of the cutter bar, and which may

be raised and lowered at the will of the operator. It is used to some extent at the present day, especially for particular purposes, as for bunching clover when cutting for seed.

In 1856 Owen Dorsey patented a self rake which was an improvement on the Hoffhein type, and was an important patent in the development of this form of machine. It is operated much like the Hoffhein machine, having "rakes which rise and fall as they rotate, and as they approach the front part of the platform descend to the level of the latter and sweep over it, raking the cut grain therefrom, and then rise at the discharge end of the platform out of the way." At first the operator could not ride, but this difficulty was overcome by the patents of T. Whitenack, February 5, 1861, and of others. This is the first patented invention of revolving reels on a vertical axis, as the invention of Hoffhein was not patented. At this period there were a great number of devices using simply a single rake for sweeping the platform, but with the last named invention the first types of the present self rake made their appearance.

D. M. Osborne and W. A. Kirby, February 10, 1857, secured a patent covering a reel supported on a single post, a feature afterward incorporated in the Kirby, a popular machine of that day.

Both rigid bar and flexible bar machines now came into use, and especially among mowers were these distinctions important. There were the two divisions, the single wheel rigid bar type and the two wheeled flexible machine. Reapers were also affected by changes in this line and were made like the mowers in both ways. A patent granted to Lewis Miller May 4, 1857, combined the reel with hinged platform, so as to preserve their relations on even ground, a very important invention. S. A. Lindsey took out a patent August 2, 1859, for a reel rake arranged to accommodate itself to a hinged platform, also covering the important combination of a quadrant platform, hinged finger beam, and frame supported by two wheels. The next year, September 18, McClintock Young obtained a patent for a "combination of a revolving reel shaft carrying diverging reel gatherers supported at one end only, the fixed double walled cam and the rake revolving

around said shaft and oscillating on an axis both eccentric and transverse to said shaft, with counterpoise to equalize the movement of said rake." The shaft of this was not vertical, but resembled that of the ordinary horizontal reel, and shows the manner of developing an important feature from the forms that preceded it. This invention is of special importance, as it was the foundation patent of the McCormick self rake. The Whiteley patents, embodied in the Champion machine, were taken out at this date. In 1862 James S. Marsh took out a patent for a revolving rake and reel, the arms of which were hinged to the revolving wheel independent of each other. Finally, may be mentioned the patent of Samuel Johnson, February 7, 1865, for his celebrated reel rake, in which all the revolving arms carried rakes and were each hinged independently and all controlled by the operator. This was the Hoffhein type practically completed, and needed but detailed improvements to make the self rake of to-day. With this patent the self rake was virtually complete, and thereafter the many inventions referring to it were only in details. It had not long to remain king, however, for by 1870 the binder was coming into use, and the fate of the self rake, except for particular places or purposes, was practically sealed.

The term harvester may, in its broadest sense, be applied to the modern self binder as well as to the header of the western plains and of Australia. Long before the self rake had reached perfection, invention had been going on in both these directions and various forms of machines had been devised. Even before a practical cutting apparatus had been produced efforts were being put forth toward making a device for heading and thrashing grain, and also to discover some mode of forming the cut grain into sheaves.

Taking up first the efforts made to construct a machine having an automatic binding apparatus, it is desirable that such machines be divided into two general classes: Those in which the binding device is attached to a machine of the self rake pattern, called the "low down" class, and those in which the grain is elevated to the binder, as in the present form of the machine.

Early devices for binding were very crude and differed greatly from the present form. Materials used for the band in these early forms were of three kinds—straw, wire, and twine—various attempts being made to use each of these materials. Many of the early devices, although automatic in the binding, required an attendant to furnish the power, while others required an attendant also in helping to bind.

The first attempt on record to bind grain by machinery was by John E. Heath, of Ohio, whose patent was granted July 22, 1850, and called for a twine or cord binder. His claims in patent specifications were: "First, gathering the grain and compressing it into a sheaf, by means of the rake and standard; second, carrying the cord around the sheaf and holding the latter until the band is tied by means of the curved lever and toothed arm; third, the employment of split thimble and sliding hook to aid in tying the band." Little is known of this binder except from the patent. It was on the "low down" principle, as were all the early machines and the rake mentioned in the first claim worked beneath the platform.

In 1853, J. E. Nesen patented a straw binder worked by an attendant, and Geo. Yost, in 1856, received a patent for a binder using cord cut into lengths for binding, which was also worked by an attendant.

The next device which need be noticed was invented by C. A. McPhitridge November 18, 1856, and was the first wire binder. The wire was coiled upon a reel and delivered to a reciprocating binding arm, receiving the ordinary twist and cut of the later machines. During the year 1857 four patents were granted in this line, but all pertained to straw binding and were of little value.

Now came an invention which in an indirect way was to revolutionize binder building. It was the invention of C. W. and W. W. Marsh, of Illinois, patented August 17, 1858, and was known as the Marsh harvester. It had a frame much like that of the modern binder, with a canvas which elevated the grain over the drive wheel into a receiving box, and from which it was taken and bound by two men riding on the machine. This was not the first attempt at a harvester

that carried men to do the binding, but the first that was practically successful. Augustus Adams and J. T. Gifford had built a machine in 1850 which delivered the grain by an endless canvas to two or more attendants who bound it into sheaves. It also had a box for receiving and carrying the sheaves until enough were collected for a shock.

The first Marsh harvester was built on the home farm in 1858. The next year 12 machines were built, but most of them failed by reason of poor construction, and not because of faulty principle. They kept at work, however, and in the winter of 1860–61 William W. Marsh and J. F. Hollister built a machine which was worked successfully for their harvests. Through the aid of William Deering, Lewis Steward, J. D. Easter, and E. H. Gammon, who early became connected with the firm, the business continued to grow, and from it has developed the Deering Harvester company of to-day. It was in building a machine to which the practical forms of binding device could be attached that the Marsh brothers established a landmark in the development of harvesting machinery.

But while this framework of the moaern binder was being developed, the binding apparatus was also being perfected, although attached almost without exception to machines of the self rake type. Up to this time, however, nothing practical had been produced in the numerous attempts at straw, wire, and cord binding devices. Passing over several ingenious straw binders brought out in 1858 and 1859, we come to the patent of J. D. Osborn, June 14, 1859. This is shown by the patent specifications to have had "a binding knot composed of three loops passed through each other," etc. The cord or twine was taken from a reel. Again omitting several unimportant devices we come to that of H. M. and W. W. Burson, patented June 26, 1860, which was a twine binder to be used upon any reaper, and which tied by means of hooks working together. It was not automatic.

The next important invention was that of Jacob Behel, patented February 16, 1864. It was the knotting bill which is used with little modification on almost all binders of the present day. Connected with the bill was a turning cord

holder, consisting of a small notched wheel which held the cord. The bill seized the portions of the cord which were to form the knot, and looping it, moved past a knife which cut it off in the proper place, leaving the end of the cord from the ball firmly held by the turning wheel. Mr. Behel took out other patents, and by 1865 had a knotter which worked well.

May 31, 1870, a patent was taken out by George H. Spaulding for an improved grain binder of the Marsh harvester type. This machine contained the important feature of an automatic binding mechanism which made bundles of uniform size. The value of this invention was quickly recognized by manufacturers and incorporated in their machines.

The next name that should be noticed is that of Sylvanus D. Locke, who first took out a patent for an automatic binder in 1871. He took out various patents and made a fairly successful wire binder, which he finally attached to a harvester of the Marsh type through the aid of Walter A. Wood. This machine was first put out in 1873, and became a popular machine of that time.

While Locke was perfecting his machine James F. and John H. Gordon, in connection with Mr. Deering, of the Marsh Harvester company, were working on a machine, also of the wire binding type. John H. Gordon produced his first packer binder in 1873, and his brother soon after brought out what was known as his "crane" wire binder, both machines becoming popular. These machines were put out by Gammon, Deering & Stewart and D. M. Osborn & Co., while C. H. and L. J. McCormick soon began the manufacture of the Withington type of wire binder, one of the most successful wire binders ever put out. It differed from the Gordon and Locke machines in its chain movement, in having two spools of wire from which the bands were formed, and in other devices. All these were attached to the Marsh type of machines, and were fairly good machines. But about this time, when wire binders were becoming widely used, and when it seemed that these companies had the market in their power, the cord binder forged to the front and the wire binders were doomed to extinction.

In 1875, however, John P. Appleby, who, as early as 1858, had invented a successful twine knotter, but who had since that time been devoting his time to wire binders, again turned his attention to cord machines. He connected himself with Parker & Stone, of Beloit, Wis., and with their aid built an automatic binder that promised well. It was the foundation of the binding apparatus which is used on almost every binder to-day. It combined the good points of the preceding inventions in a great degree, with some principles original with the inventor. It underwent improvements during 1876 and 1877, and through the aid of William Deering was still further perfected during the two following years. By 1880 it was practically perfected, and 3,000 were put upon the market. The Deering, McCormick, Champion, and Osborn companies at once procured rights and began the manufacture of this type of binder in combination with the Marsh style of frame, adding various improvements in details as they saw fit. This style of machine immediately leaped into popular favor. All others were soon distanced in the race for superiority, and the binders of the present are simply this type of machine more nearly perfected. From that day the modifications have been in detail and not in principle. It is true that among the twenty odd manufacturers of machines there are found types differing considerably from this, but they are not among the most popular machines.

The first attempts at a reaping machine were probably in the form of a header. In regard to the first historical account we know this to be true, for Pliny describes one at work in the fields of Gaul, which was of this type. It is probable, too, that some forms of the harvester were in use by the ancients, of which we have no record, since historians gave their attention to other than agricultural subjects. The earliest English machines were also after the form of the old Gallic stripper, so that this mode of harvesting is not new. In America various attempts have been made to construct heading machines, the trials reaching back to the earliest inventions in reaping machinery, while from the very first, attempts were made to build a thrashing apparatus in connection.

The most important invention was that of Jonathan Haines, of Illinois, patented March 27, 1849, and known throughout the west as "Haines's Illinois harvester." As improved, it was a thoroughly practical header and large numbers of them have been sold. It had a device for raising and lowering the cutters, and cut a very wide swath. It is this style of machine that is now used in great numbers on the plains of the west. This machine is fitted with a very long cutter bar and reel, and by means of a long canvas elevator carries the heads to one side, where they are deposited in a wagon with a bed fitted for the purpose. It is pushed by attaching four horses abreast to the tongue in the rear, and guided by a wheel steering device. Six men and ten horses can by the aid of this machine cut and stack from 15 to 30 acres per day.

In some parts of the west, especially in California, where there is no fear of rain during harvest, a combined harvester and thrasher is used, which heads, thrashes, separates, and sacks the grain. It is propelled either by a traction engine or by horses. If horses are used, from 30 to 36 are required, and if steam is used more men are needed than if horses furnish the power. The machine has a capacity of from 60 to 125 acres per day or from 1,700 to 3,000 bushels. These machines have done a great deal toward developing the immense wheat output of the western country and should hold no small place among the harvesting appliances of the present day.

American harvesting machines are the most perfect in the world, and have been introduced into almost every country on the globe.

In the early development of the mower, it was so intimately connected with the reaper that a little space should here be devoted to a short review of its history. Hussey's first machine was really a mower, and it was upon this principle that the mower was afterwards built. Many of the early machines contained combinations of the mower and reaper, and were used with a little adjustment to cut either grain or grass.

The idea of a separate machine for cutting grass was conceived in America, the first attempt to construct such a ma-

chine being by Peter Gaillard, of Pennsylvania, whose patent was dated December 4, 1812. The machine was not successful, however, and it is remarkable only as being the first. The next was by Jeremiah Bailey, February 13, 1822, and was on the revolving cutter plan. It gained some notoriety at the time, and worked with a slight degree of success. Another important invention was that of Wm. Manning, patented May 3, 1831. It was really a reaping machine, but contained the principle of the reciprocating knife which afterwards became so famous as the basis for all mower cutters.

This brings us to the celebrated patent of Hussey in 1833, the foundation of the modern mower. Hussey's combination of the reciprocating knife and slotted guards is used with some improvements upon all mowers of the present day. Hussey brought out the principle; others helped to perfect it. The history of the mower from 1833 to the present day has been simply a perfecting of this type of cutter bar, and the working out of certain necessary details.

In this development there were two classes of machines—those having a rigid bar and single drive wheel, and later, those having the double drive wheel and flexible bar. In the first type there was sometimes a smaller wheel to support the cutter bar, and sometimes none; while in the latter the cutter bar was jointed to the machine, and had, if any, only a small roller at the end.

A name that stands out prominently in the development of mowers is that of William F. Ketchum, who has sometimes been spoken of as the father of the mower trade, since he was the first to put mowers on the market as a type of machine distinct from the reaper. He took out several patents, but the one granted July 10, 1847, was of especial importance. The main features of this patent were the unobstructed space left between the driving wheel and the finger bar with its support, and the remarkable simplicity of the machine. The cutter was an endless chain of knives, which never became successful, but which caused some excitement at the time. Ketchum afterwards adopted the Hussey type of cutter and produced a very successful mower of the rigid bar type. It was this machine that led the way

in mower development and became the first really practical machine.

In 1850 Ebenezer Danford, of Illinois, patented a machine with a double knife cutter, previously described. This was a strong machine and one of the most successful up to this time. By 1855 this type of the fixed bar machine had been perfected, but it lay with the flexible bar machines, which were now coming into use, to sweep from the market the former type.

The first invention showing the feature of a flexible bar was that of Hazard Knowles, the machinest of the patent office at Washington. It showed many valuable features of a reaping machine also, but no patent was taken out. The patent granted to Cyrenus Wheeler December 5, 1854, marks the division between the two types of machines. Wheeler was a practical man, and, like McCormick in the development of the reaper, succeeded in combining so many important features in his machines as to give him a place as one of the foremost pioneers in the development of the mower. The machine of 1854 was not a success as constructed, but the features of two drive wheels and a cutter bar joined to the main wheels were lasting.

A careful study of the reports of some of the mower trials which were held about this time would be of use in showing what machines were then in use and to what degree they were practical. At a trial of mowers and reapers at Springfield, Ohio, July, 1852, three combined machines and three mowers were entered. The combined types were by McCormick, Purviance, and Smith, and the mowers by Hussey, Castle, and Ketchum. McCormick's mower was simply the reaper with platform removed and with the cutter set low. It did not operate well, however. Purviance's mower was also the reaper with platform removed and cutters lowered. The alteration was easily made and the machine operated quite well, but the committee gave as its opinion that combined machines were not so good as the separate types. This was undoubtedly correct, for the combined machines soon dropped out of view on the appearance of the mower.

Smith's combined machine was the third mower and reaper exhibited at the above named trial, but it failed to do good work. As to the mowers shown, Hussey's was quite simple and operated well, but required three or four horses. Castle's, a creditable machine, with a reel and two series of knives, worked somewhat like Bell's old English type. The committee expressed itself as doubtful as to its operating when the knives became dull. Ketchum's was the simplest and most durable in construction and quite light in draft. It took the first prize, with the Hussey machine second. The report shows that Ketchum had a very practical machine in 1852, with Hussey a close second.

Another trial at Geneva, N. Y., about the same time, shows Manny's, Ketchum's, McCormick's, Murray's, Rugg's and Danford's machines among the contestants. Manny's had a peculiarly constructed frame, and the knife could be regulated while the machine was in motion. A reel was used, and the cutter sections showed the early efforts to prevent clogging by placing the back part of the edge of each knife in contact with the guard, a modification of the Hussey cutter. Ketchum's had a simple compact construction, with an iron elbow connecting the cutter bar with the running parts of the machine. It was the same style of machine as exhibited in the trial at Springfield. McCormick's machine had obtuse sickle edged sections and also the form of spear shaped fingers patented in 1847. The machine was too frail, and the knives could not stand the strain. Rugg's resembled the old Bell machine, having the horses in the rear. It had a means of raising and lowering the cutters at will, but soon ceased to operate. Danford's was also used as a reaper, and had a double crank with blades reciprocating past each other. Hussey, McCormick, Cook, and Burrall exhibited combined machines.

At a trial in 1855 at Flushing, N. Y., there were five entries, Manny taking first and Ketchum second prize. At a contest two years later there were five entries—Wood's, Ketchum's, Allen's, Bartlow's, and Harmon's. Ketchum took first and Allen second prize. At the trial at Geneva in 1866, twenty different mowers were entered, so that it is

seen that an immense amount of work had been done on this machine, and from the great number in competition it is evident that the successful mower had been developed.

Returning to the history, however, we find that in 1855 a patent was granted to Jonathan Haines which was very important in the development of the flexible cutter bar. It had two drive wheels and a cutter bar jointed to the main frame in such a manner that it could be lifted over obstructions, and the tongue was rigidly fastened to the main frame.

On July 17, 1856, a patent was granted to Cornelius Aultman and Lewis Miller containing principles that still exist in all successful mowers. The first patent claimed "connecting the cutter bar to the machine by the double rule joint or the double jointed coupling pin." It was reissued to cover an arrangement for holding up the bar while moving, and the combination of ratchet wheel, pawl, and spring. On May 4, 1858, Lewis Miller took out a patent on a mower that combined the features of the former machine with some new principles. It contained all the elements of the successful modern two wheeled machine, and mower development since that time has been a perfecting of this type. This machine was built under the name of the "Buckeye," and, with a substitution of metal for certain wooden parts, and certain other improvements, it is in use to-day. E. Ball, associated with this firm, also made valuable improvements in mowers. In 1856 a patent was granted to A. Kirby, covering improvement made by him a few years previous, and his machines soon became popular. Others took up the manufacture of mowers at this early date, so that by 1860 the mower had become a thoroughly practical machine, and was being improved by various firms throughout the country. This improvement has gone on with the many makes of machines now in existence, and to-day we have various forms, from the single one horse machine to the large two horse type, with its long cutter bar, running with as light a draft as the former clumsy machine did with a cut but half as wide. As a result of this development the amount of hay produced in the United States has increased enormously, and to-day it stands as one of the most important crops.

AGRICULTURAL PRODUCTION AND PRICES.

BY GEORGE K. HOLMES.

[George Kirby Holmes, statistician; born, Great Barrington, Mass., May 10, 1856; educated in the public schools; studied law and admitted to Massachusetts bar in 1877; special agent in charge division of farms, houses and mortgages, United States census, of 1890; now statistical expert in charge of domestic crop reporting, United States department of agriculture; Author: Farms and Homes, Real Estate Mortgages; writer on economic and statistical subjects.]

Foremost among countries in agricultural resources, equipment, and production, the United States affords an interesting and important subject for statistical examination with respect to agriculture. Here is a country covering the breadth of the North American continent and extending almost to antarctic regions on the north and fully to semitropical regions on the south, with an area of 2,939,000 square miles, not including Alaska and Indian Territory, of land surface, of which 838,591,774 acres were in farms in 1900 and 414,498,487 acres were under cultivation, and within this great area the variations in soil, altitude, heat, moisture, rainfall, and other agricultural conditions are so numerous and so considerable in degree that the products of agriculture are of many kinds and bountiful, so that the world market is largely affected by many of them.

Great and rapid development has characterized the agriculture of this country. The number of farms increased from 1,449,073 in 1850 to 5,737,372 in 1900; their total acreage increased from 293,560,614 acres to 838,591,774; their improved acreage from 113,032,614 to 414,498,487 acres, and their unimproved acreage from 180,528,000 acres to 424,093,287. The largest percentage of increase of improved land within a decade since 1850 was 50.7—from 1870 to 1880; next to this was an increase of 44.3 per cent—from 1850 to 1860; third in order was the decade 1880 to 1890, with an increase of 25.6 per cent, while the lowest percentage of increase was in the decade in which the civil war occurred, and was 15.8.

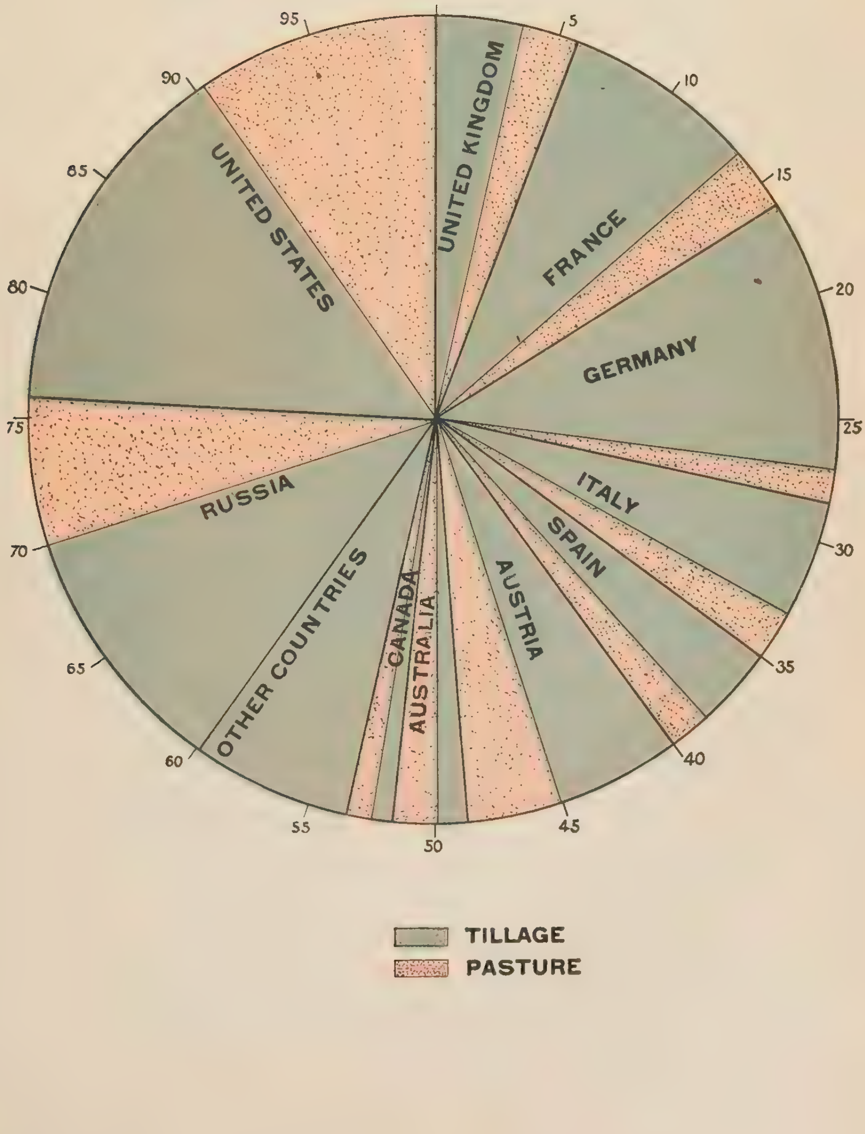
By far the largest portion of the people are engaged in agriculture in comparison with the other great groups of occupations, known as mining, fishing, manufacturing, domestic and personal service, professional service, and trade and transportation. The number of persons reported in 1890 to be engaged in agriculture for gain was 8,395,634, of whom 678,142 were women, and the entire number is 36.9 per cent of all persons having gainful occupations. This percentage may be regarded as substantially representing the agricultural portion of the population if the farm family is of about the same size as that of the rest of the population.

What effect upon agricultural production the drift toward farm tenancy has it is impossible to establish, but the common supposition is that in this country farm tenancy is detrimental to production, because the tenant's interest in maintaining the productivity of the farm is not as great as that of the owner.

The productivity of farm labor as measured in wages is represented by a low figure, as is the case with unskilled labor in general. Wage rates for this labor have been ascertained by the department for a long series of years, beginning with 1866, when the monthly pay of an agricultural laborer without board was $19.07. It rose to $19.49 in 1869 and fell to $16.42 in 1879. In 1882 the rate was $18.94, and in 1885, $17.97, after which there was a rise to $19.10 in 1893, followed by a fall to $17.69 in 1895, during the financial depression.

In this age of agricultural machines the area of a farm has some relationship to agricultural production. A farm may be so small that its owner can not afford to own expensive machines, and, although this difficulty is obviated in many parts of the country in the cases of some crops, as in the ginning of cotton and in the thrashing of wheat by men who do this work for a neighborhood of farmers at a rate per pound or bushel, yet, generally speaking, a farmer with a small farm does feel his limitations in the purchase and use of machines. While it might be too much to claim that the average area of farms is economically the best one, it may be more reasonable to suggest that it is adjusted to the financial ability of the owners. At any rate, whatever may be the

VALUE OF AGRICULTURAL PRODUCTS



cause or causes of changes in average farm areas, the fact is that they uninterruptedly diminished from 1850 to 1880, and, outside of comparatively small regions where new land has been taken in large farms for wheat raising, mostly between the Missouri river and the arid region and on the Pacific coast, there was a diminished average farm area from 1880 to 1890.

So large in quantities are the crops produced in the United States that numbers of pounds, tons, and bushels fail to convey anything more than a vague conception of their amounts. To put the matter in form for better intellectual grasp, computations have been made to ascertain the number of railroad freight cars, each of 15 tons capacity, required to haul the annual crops, and what their length would be.

To haul the hay crop 4,017,933 cars would be needed, and the length of the train would be 25,112 miles, or more than long enough to encircle the earth at the equator; for the corn crop there must be 3,540,257 cars, making a train 22,127 miles long; the wheat crop would take 1,060,000 cars, with a total length of 6,625 miles, or farther than from New York to Cape Horn; a train of 772,098 cars, extending 4,826 miles, or from New York to the Congo river, would be required for the oat crop; a train of 327,354 cars, and 2,046 miles long, to move the potato crop, and this train would extend from New York to Utah; a train to haul the cotton crop would be as long as from New York to Chicago, and one to haul the barley crop would reach from Washington, D. C., to Atlanta, Georgia.

Raising, as this country does, a larger amount of agricultural products than its people can consume, the exports constitute a considerable portion of some of the crops, as the table following shows. The average portion of the corn crop exported annually is 5.4 per cent; of wheat, 16 per cent; of rye, 12.2 per cent; of oats, 2.2 per cent; of barley, 13 per cent; of tobacco, 67.4 per cent; of cotton, 73.6 per cent.

It is to be remembered that large portions of some of the crops are exported in the form of animals and animal products.

In recent years predictions have been made of the near approach of the time when our domestic consumption will

overtake domestic production of various crops, especially of wheat, but the predictions seem hardly nearer realization as time passes, and the potential expansion of acreage, as demand and price become strong and high, promises a surplus for export for many years to come.

For domestic requirements 28.6 bushels of corn are needed per capita, 5.5 bushels of wheat, and 10.7 bushels of oats, the computations being made in the usual way upon the figures of exports, imports, production, and population.

Therefore, it follows that 1.15 acres in corn are required per capita for domestic consumption, 0.43 of 1 acre in wheat, and 0.43 of 1 acre in oats. This gave us a surplus area in corn of 2,648,404 acres above domestic requirements, of 11,-264,478 acres in wheat, and 238,162 acres in oats.

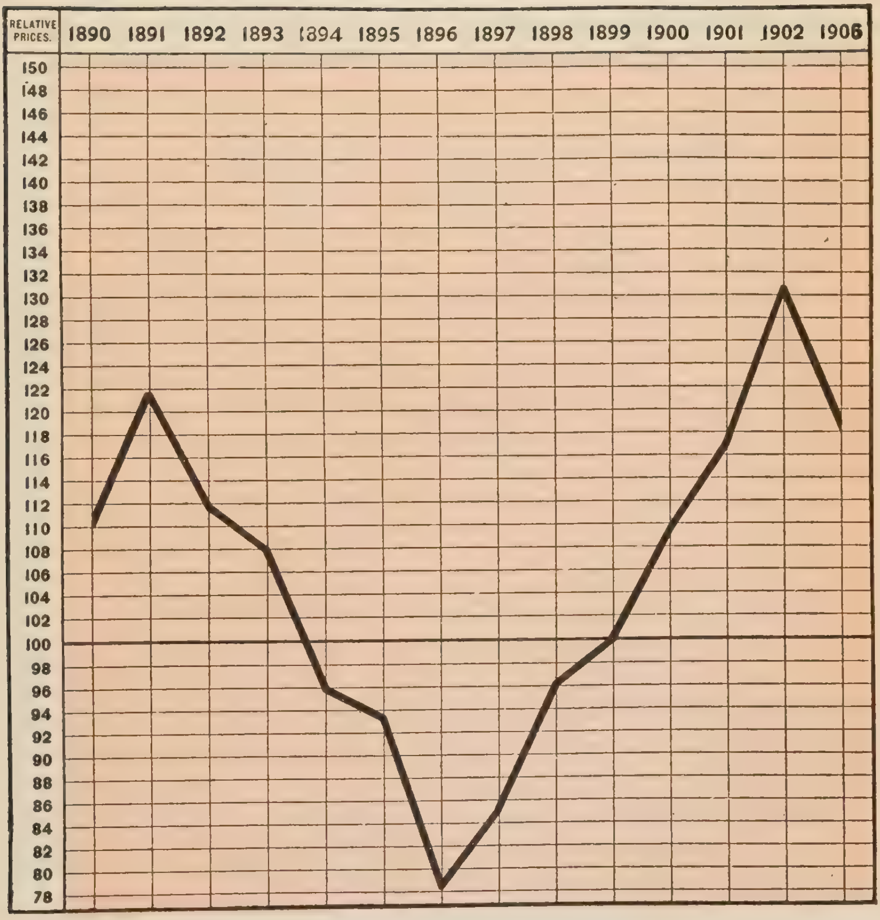
Corn had the average farm price of 42.6 cents per bushel in the ten years 1870 to 1879, 39.3 cents in 1880 to 1889, and 35.5 cents in 1890 to 1896 and 44.1 in 1904. The farm price of wheat declined in a more marked degree, the prices for the four periods being 104.9, 82.7, and 65.8 and 91.0 cents, respectively. The farm prices of the other cereals also declined during the twenty seven years, but in 1904 had shown an advance.

In farm value of product per acre, corn averaged $11.54 in 1870 to 1879, $9.48 in 1880 to 1889, $8.55 in 1890 to 1896; while wheat averaged $13 in 1870 to 1879, $9.98 in 1880 to 1889, and $8.54 in 1890 to 1896.

Nothing conclusive with regard to increasing or decreasing fertility of soil is revealed in crop statistics of acreage and production. The extension or contraction of crop area may have the effect of raising or lowering the average yield per acre in the whole country. The average bushels of corn produced per acre were 27.1 in 1870 to 1879 and 24.1 in each of the periods 1880 to 1889, 1890 to 1896, and 26.8 in 1904; of wheat, 12.4 in 1870 to 1879, 12.1 in 1880 to 1889, and 13 in 1890 to 1896, and 12.6 in 1904. Oats declined from 28.4 to 25.2 bushels from the first to the third period, but advanced in the last, while barley, rye, and buckwheat also advanced in the last period.

RELATIVE PRICES OF FARM PRODUCTS, 1890 TO 1906

[AVERAGE PRICE FOR 1890 TO 1899=100.]



The prices of agricultural products, especially those that have a world market, have tended toward a narrower range of fluctuations in a marked degree. Cotton prices may be cited as an illustration. The range in the prices of middling upland cotton per pound in New York has been ascertained for each year from 1821 to 1895, and the ranges have been averaged for groups of years. For the ten years 1821 to 1830 the average range of prices was 7.35 cents; 1831 to 1840, 7.60 cents; 1841 to 1850, 4.12 cents; 1851 to 1860, 3.46 cents; 1861 to 1870, 43.95 cents; 1871 to 1880, 4.16 cents; 1881 to 1890, 1.77 cents; 1891 to 1895, 2.21 cents; and 1904 the price was 11.75 cents.

That the wholesale market price of wheat and many other farm products should be less now than in earlier years is partly accounted for by the diminished cost of transportation. The freight rate on a bushel of wheat from Chicago to New York in 1870 was 25 cents; in 1896 it was 8.23 cents, and in 1904 it was 6.94. The rate per mile per ton of freight on thirteen large railroads was 1.37 cents in 1870; it was .71 of 1 cent in 1896. On all of the railroads of the United States this rate declined from 1.29 cents in 1880 to .81 of 1 cent in 1896. So greatly have the freight rates declined that the farm value of 1 bushel of wheat now pays for the transportation of 6.05 bushels from Chicago to New York, as against 4.44 bushels in 1867.

The chief causes of our nearly ten million bale cotton crop were ideas that were in the minds of inventors many years ago. This great crop is absolutely dependent upon the invention of the machines of the cotton mills and upon the cotton gin, which have made the cost of production of cotton fabrics very cheap, and thus made markets for enormous quantities of them. This is brought out forcibly by mention of the various inventions and the consequent extraordinary increase in the imports of cotton into Great Britain.

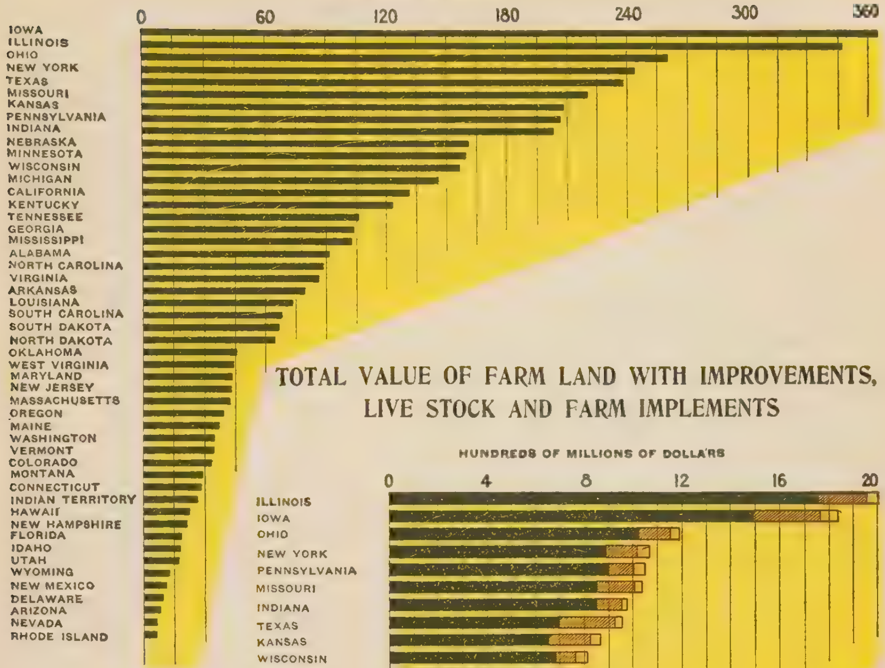
The extraordinary importance of some of these machines may be understood from the statement that before Whitney's invention of the cotton gin one person could pick the seed from only about 1½ pounds of cotton lint in ten hours, while at the present time one machine will gin from 1,500 to 7,500

pounds of lint in the same time, the quantity varying according to the size and power of the gin.

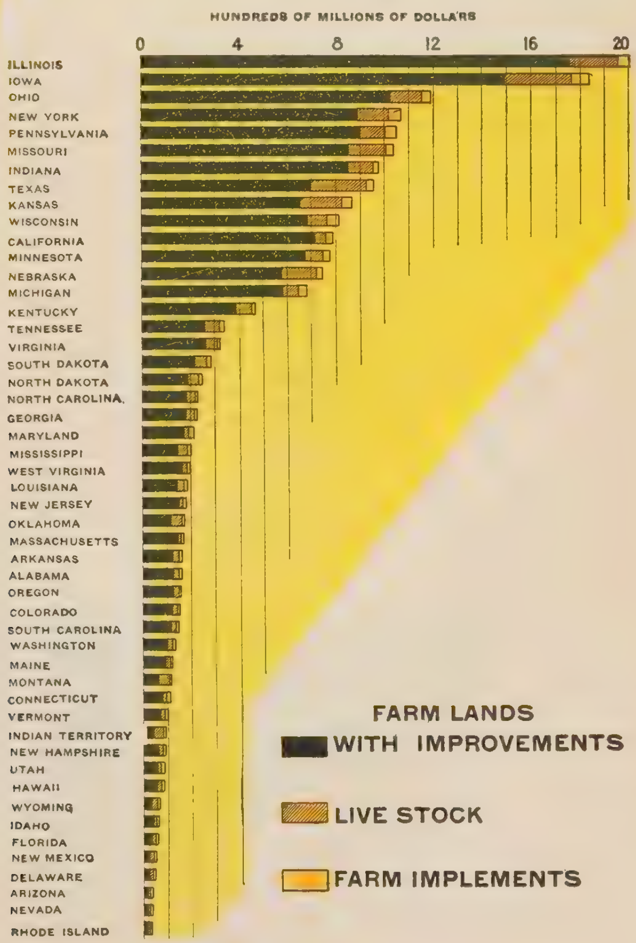
For some years magazine and newspaper writers have been prophesying that upon complete or nearly complete disposal of the better public land the production of corn and wheat, at least, would be arrested, and, while domestic consumption is absolutely increasing, the exported fraction of these crops would be diminished; but the prophets have not taken into account the possible redistribution of cultivated land among the various crops, nor the conversion of unimproved into cultivated land, nor have they recognized the expanding consumption of commercial fertilizers, especially in the cotton states, and the dissemination of information with regard to technical and scientific agriculture through the efforts of the agricultural department, the boards of agriculture of the various states, and the many experiment stations, all of which agencies are in more or less close touch with millions of the farmers of the country.

The changes that agricultural production, especially the preparation of agricultural products for the market, have undergone within the last half century, and still more within the last quarter century, are remarkable and important. There is a great difference in results between the time when, as ascertained by the United States department of labor, 20 minutes of human labor were required to husk a bushel of corn by hand, with the use of a husking peg, and 102 minutes to haul the stalks required to produce a bushel of corn to a barn and cut them into fodder, and the time, as at present, when $17\frac{1}{2}$ minutes are sufficient to haul the same stalks to a husker and, by the use of a machine operated by steam, to husk the corn and at the same time cut the stalks into fodder; and there was a transition from one agricultural age to another when a man ceased to expend 160 minutes of labor in shelling corn by hand, and employed a steam sheller by which a bushel of corn is shelled in a minute and a half. When farmers reaped their wheat with sickles and bound the straw by hand, hauled the sheaves to the barn and thrashed the grain with flails, these operations, applied to 1 bushel of wheat, required the labor of one man for 160 minutes, whereas this work is

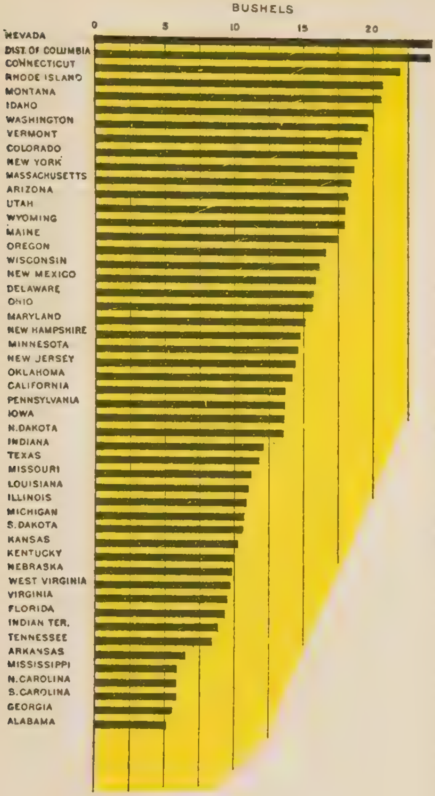
TOTAL VALUE OF FARM PRODUCTS



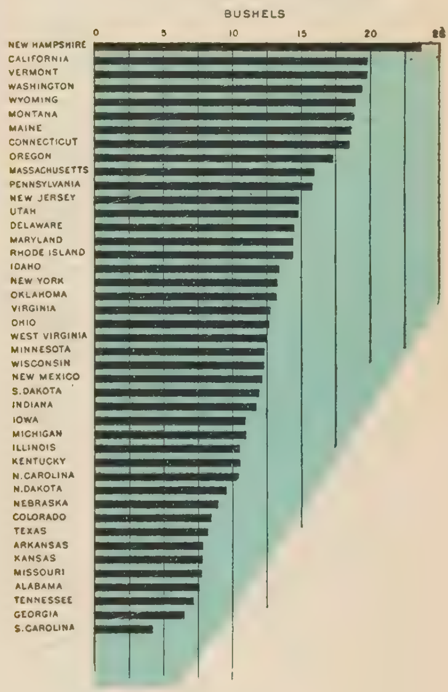
TOTAL VALUE OF FARM LAND WITH IMPROVEMENTS, LIVE STOCK AND FARM IMPLEMENTS



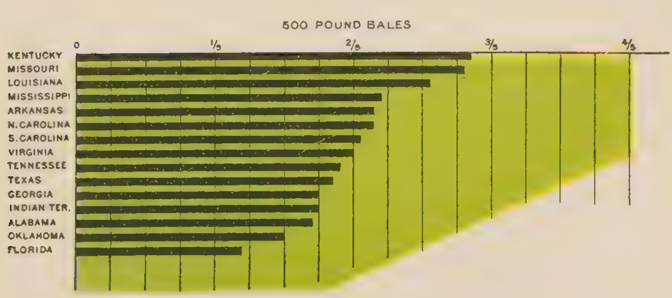
AVERAGE YIELD PER ACRE OF WHEAT, 1900;



AVERAGE YIELD PER ACRE OF BUCKWHEAT, 1900.



AVERAGE YIELD PER ACRE OF COTTON, 1900;



Note: States and territories producing less than 100 bales, are not shown

now done, by the use of a combined reaper and thrasher operated by steam, with 4 minutes of human labor.

Present conditions indicate that a subject of growing importance in agriculture will be the use of fertilizers, both home made and commercial. There was a time when it was the practice of the cotton planters to crop the soil until it became so unfertile that it was abandoned, whereupon new land was cleared of its forest and the exploitation of soil fertility repeated. But such a practice as this, in the case of nearly all agricultural land, must end in the poorest sort of agriculture, if not in the abandonment of agriculture, and so farmers have resorted, and now are still more resorting to the use of fertilizers. The use of these, in the cultivation of cotton, presents economic advantages to farmers, and teaches them rather to cultivate well the land that they cultivate at all than to cultivate poorly a larger area.

The foregoing consideration has been sufficient to account on economic grounds for some of the reduction in prices of farm products—production increasing faster than population, necessitating the meeting of cheaper foreign agricultural labor in the world market; cheaper transportation; cheaper cost of production due to machines and improved implements; reduced expenses of marketing; the dissemination of information and the multiplying of the means and facilities of transportation, preventing scarcity with respect both to time and place, and thus steadying prices.

COTTON.

BY JOHN GILMER SPEED.

[John Gilmer Speed, author and journalist; born in Kentucky, September 21, 1853; graduate, University of Louisville, 1869; practiced civil engineering, and became city engineer of Louisville; with United States board of transportation at centennial exposition, 1876; with New York World, 1877; mining editor, New York World, 1879–83; secretary American exhibition, London, 1887; editor, American Magazine, 1888–9; editor of Leslie's Weekly for two years; edited Keats' letters and poems, and wrote a life of the poet Author: A Deal in Denver, A Fall River Incident, The Gilmers in America.]

Cotton is the most important crop in the world, and the United States supplies it in much greater quantity than any other country, supplies even a very large proportion of all that is used. This indicates what a large figure we are cutting in the world when we supply it with a tremendous proportion of the raw material for its clothing from our farms, and when that material is not the first in value among our agricultural products. Indeed, in a comparative sense, we are new as a cotton country, though for much more than half a century there have been pseudo economists who advanced the idea that we were raising too much cotton and not enough corn. If it be not essential to the progress of the world that all should not agree, the differences of men surely contribute to the gayety of our life.

When cotton was first raised we do not know; when it was first woven into cloth we know not. But there is a great certainty that both these beginnings happened in India. There, for an indefinite period, cotton has supplied the chief clothing used by that dense population; and with crude machinery they had in that land of mysteries attained most remarkable skill in weaving muslins thousands of years ago. Indeed, it is quite within the truth, I believe, that they were more skillful in India in making cotton cloths than anywhere else in the world up to the middle of the eighteenth century. About that time Hargreaves, Arkwright, Crompton, Cartwright and Watt, men either directly or indirectly engaged in and familiar with the needs of cotton manufacture, invented

machines which raised the trade from an experimental, or, at least, a struggling, industry into the most important manufacture in the world. The carding engine, the spinning jenny, the stocking frame, the power loom, and the adaptation of the steam engine to the propulsion of these machines at once supplied the means of producing an immense amount of yarn and cloth.

In the western hemisphere cotton must have been indigenous in the semi-tropical parts, for Columbus found it growing abundantly in the West Indies in 1492, while Cortez found it in Mexico in 1519. He gathered it and used the wool to stuff the jackets of his soldiers as a protection against the arrows of the natives. Indeed, at that time the wool was woven into fabrics in Mexico, and these were the chief clothing of the Mexican people. In Peru, also, where there was an ancient civilization, Pizarro found cotton in 1522, and an examination of the tombs showed that very old mummies were swathed in cotton cloths. This indicates a very ancient manufacture of cotton in the land of the Incas, and shows that their practice was different from that of the Egyptians, who always used linen for this purpose. In what is now the cotton belt of North America, cotton was not used until our ancestors came and, beginning its cultivation as a garden plant, soon learned how to weave it for domestic use. The early governors of Virginia encouraged its growth, and in Maryland and Delaware it was also grown. In North Carolina, in the colonial era, the cotton grown in that state, and weaved by the women, supplied quite one half of the clothing of the people. It was early grown also in Georgia, and cloths woven there were sent to London. The governors of the Georgia company did not approve of that, however, and the colonial authorities in America were asked to discourage the manufacture of more cloth than was needed at home, and to encourage the shipment of the raw material for manufacture in England. This was one of the early methods of protecting English industries in the eighteenth century.

And except for the domestic manufacture in its strictest sense, that is, in the individual homes of the people by the women of the family, there was practically no manufacture

of cotton in this country till long after the winning of our independence. Nor did the exportation of cotton into England reach large proportions until we had turned the century mark and begun dating our bills of lading with an "18," instead of a "17." Previous to that we had used pretty nearly all of our cotton at home. In 1739 a sample of cotton was taken to London by Samuel Anspourger, a Swiss living in Georgia, and Dana in his interesting work, Cotton from Seed to Loom, counts that as the starting point of the exportation to Europe. In 1787 we sent 16,350 pounds, and 1788 there were exported 58,500 pounds. This increased to 127,500 pounds in 1789, decreased to 14,000 pounds the next year, increased to 189,500 in 1791, and to 138,328 pounds in 1792. Now we may say that the industry had been started, but it was a very weak infant and sadly needed to grow in size and strength. This it did right merrily and the infant soon became lusty and valiant.

We have long done a great deal of cotton spinning on our own account. The first of our mills was built at Beverly, in Massachusetts, in 1788. By 1831 we had 801 mills in operation. Now the industry is so extensive that we consume, or rather manufacture, annually something like one third of the crop that we grow, and some of this is spun right where it is grown, that is, in the southern states. Five million, six hundred thousand bales produced in 1860 dwindled to two and a half millions in 1865. The period between was that of our great civil war, and this was known in Manchester and other cotton manufacturing centers in England as the time of the "cotton famine." And a dreadful time it was there. There was not only not enough cotton to keep the mills in operation, but the price of cotton soared out of all bounds. In 1860 the average price was eleven cents a pound. In 1861 it got as high as 38 cents; in 1862 it reached 69½; in 1863 it rose to 93; in 1864 it touched $1.90, while the lowest, in 1865, was 35, the highest being $1.20.

Mills had to be closed or worked on such short time that starvation stared the operators in the face. England never faced a more menacing industrial crisis. And all this because the planting and shipping of cotton in the United States

had been stopped by our internal strife. No wonder that the politicians counted on the intervention of the British government.

But the making of cotton cloth, together with the planting and the harvesting of the crop, could never have become the greatest industry in the world had it not been for an American inventor, Eli Whitney, who devised the cotton gin in 1793. Great difficulty was experienced in separating the seed from the lint of upland cotton. The work was done by hand, the task being four pounds of lint cotton per week from each head of a family, in addition to the usual field work. This would amount to one bale in two years. A French planter of Louisiana (Dubreuil) is said to have invented a machine for separating lint and seed as early as 1742. The demand for such a machine not being very great at that date, no record as to its character has been preserved. The roller gin, in very much the same form as Nearchus, the admiral of Alexander the Great, found it in India, was still in use. In 1790 Dr. Joseph Eve, originally from the Bahamas, but then a resident of Augusta, Ga., made great improvements on this ancient machine and adapted it to be run by horse or water power.

In 1793 Eli Whitney petitioned for a patent for the invention of the saw cotton gin. His claims were disputed, and he defended them in the state and federal courts for nearly a generation, obtaining at last a verdict in his favor. Meanwhile the saw gin had become an established fact, and the planter at last had a machine which enabled him to produce cotton at a cost that would leave him a good profit. The first saw gin to be run by water power was erected in 1795 by James Kincaid near Monticello, in Fairfield county, S. C. Others were put up near Columbia by Wade Hampton, Sr., in 1797, and in the year following he gathered and ginned from 600 acres 600 bales of cotton.

The cotton exportations from the United States increased from 487,600 pounds in 1793 to 1,600,000 pounds in 1794, the year in which Whitney's gin was patented. In 1796, a year after he had improved his machine, the production had risen to 10,000,000 pounds. In fact, the increased

production was so great that the planters began to fear that they would overstock the market, and one of them, upon looking at his newly gathered crop, exclaimed: "Well, I have done with cultivation of cotton; there's enough in that gin-house to make stockings for all the people in America." Yet the production of cotton did not advance with that rapidity to which we are now accustomed.

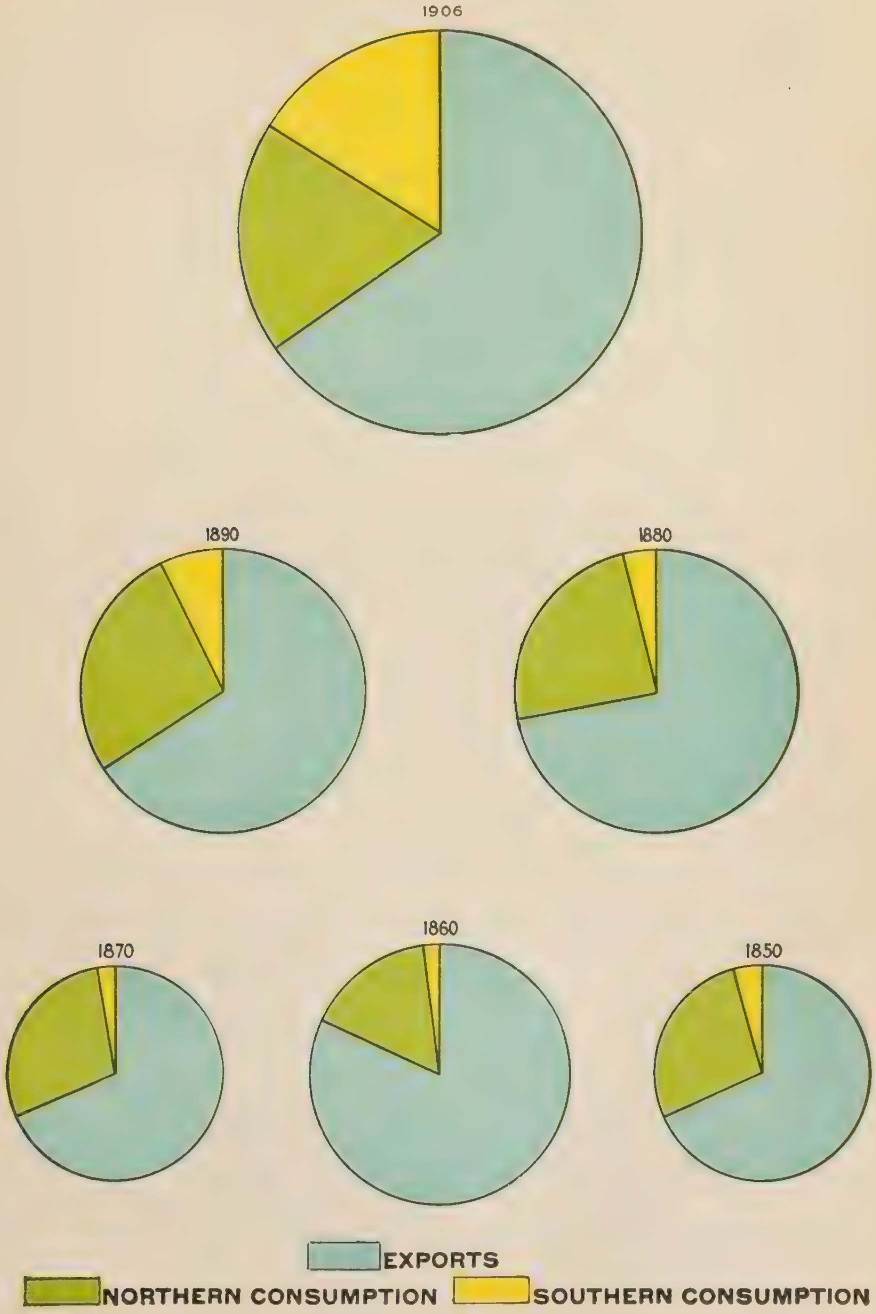
The "cotton famine" during our civil war stimulated the growth of cotton in India and in other parts of the world. In a while there was a great deal of cotton exported from India, and now the exportations from there to the looms of Europe are second to those of the United States. But the United States has regained her place and is likely to hold it. Previous to 1800 we exported 1.636 of the total imports of Great Britain. By the middle of the century we had reached the very important position of sending eighty per cent of all manufactured by the myriads of English and continental looms. That is about our position to-day, though the European looms are many, many times greater than in 1850, while our own manufacturing capacity has grown much faster. We do not grow all the cotton in the world, but we grow four fifths of it. That ought to satisfy even those who want the earth.

The cotton belt covers 24 degrees of longitude and 10 degrees of latitude. Excluding from the count the greater part of Virginia, more than 100,000 square miles of western Texas and the whole of Kentucky, Kansas, Missouri, Utah, California, Arizona and New Mexico, in all of which cotton has been cultivated, and where a larger demand might cause its culture to be extended, the cotton growing region measures nearly 600,000 square miles. The 20,000,000 acres planted in cotton occupies barely five acres in every 100 of this extensive region. Scarcely 50 per cent of this territory is in farms, and not more than one fifth has at any time been tilled. This section contains a population of over 8,000,000 whites and something over 5,000,000 negroes, in all 13,651,000, every 100 of them producing 53 bales of cotton, an average of 254 pounds of lint per capita.

In 1801 South Carolina led the other states in the production of cotton. In 1850 Alabama stood first. Mississippi

COTTON PRODUCTION, EXPORTS, AND CONSUMPTION.

1850 TO 1906



led in 1860–1880. Texas stood at the head in 1890 and still does. The center of production was near Montgomery, Ala., in 1850; this center had moved two miles west by 1860. In 1870 it was near Carthage, Miss., and in 1880 was in Noxubee county, Miss. In 1890 it was sixty miles northwest in Attala county. It is moving west all the time on account of the increasing crops in Arkansas, Texas and the Indian Territory, not to mention Oklahoma.

Cotton is now grown exclusively by small farmers of three classes—men who own their farms, men who rent their farms, men who work on shares. In the old days a large proportion of the cotton was grown by planters who worked on an extensive scale, having very large areas under cultivation and owning armies of slaves. These were the days that Mrs. Harriet Beecher Stowe told about in lurid language in her highly colored romance, "Uncle Tom's Cabin." It is likely that that method of growing cotton was very expensive and wasteful, very like the operation of burning a candle at both ends. Therefore it is probable that at the price of cotton as it is to-day the fine gentlemen who lorded it over the country for two generations before the civil war would have gone into bankruptcy in two seasons. The labor was costly, as all slave labor is, for the slaves had to be housed, fed and clothed and looked after as little children. The superintendent was inefficient, the overseers usually being northern men from a class which I trust has perished out, and also generally dishonest. Here was one end of the candle. The next end was in the market town—New Orleans, in Savannah or in Charleston. There the planter dealt with his factor, who was at once banker and commission merchant. The planter in nine cases out of ten had to get advances for supplies against his growing crop. These advances, nominally in money, were actually in supplies at the highest prices for the poorest goods, and at a rate of discount that would make a Jew blush with shame. So both ends were burning at once; but the price of cotton was high, ruling at ten cents to the pound, the demand was inexhaustible, and when the crop was in there was usually a balance for a new box of candles. That would not do nowadays. And even then among the planters there were careful

men who were good husbandmen, and so under conditions of their own making became rich. Now the labor is too uncertain and undependable for large operations in planting, and so the man who retains a large estate must have it worked on shares. He supplies the land and pretty nearly everything else his dusky tenant can wheedle out of him, including, of course, the living supplies during the growth and the harvesting of the crop. Then owner and tenant divide the crop. The margin of profit is small, for cotton only brings from five to eight cents a pound, but with good husbandry this margin can be preserved.

The general testimony is that while farmers growing cotton exclusively are in very bad condition financially, those who raise food and forage crops, and especially those who, in addition, raise their work animals, are everywhere prosperous. The chief reason of this is that the exclusive cotton grower fails to employ the most important forces in farm work, the work animals and the land, to the fullest extent. He draws upon the surplus of a single crop made in part of the year for the means to support his farm during the whole year. There is a saving in using unemployed time and capital to produce necessaries which otherwise must be paid for in money.

I have given myself no space to speak of the varieties of cotton. They are not many, but such as they are they baffle the naturalists, so I shall not bother with them. To the planter "variety" refers to that kind of seed used to produce an early or late kind, a short or a long staple. Of these there are many scores in America, but they differ from each other rather in degree than in kind. There are many "sports" in every cotton field, as pollen is produced in great excess, and is readily scattered in the lightest breeze. There are really, therefore, only two varieties, and these are the varieties of commerce—long and short staple. The cotton of commerce, however, is "middling upland," which means neither long nor short. Of the long staple cotton, the best in the world is known as sea island. It takes its name from the sea islands off the coast of Georgia and South Carolina. Sea Island cotton is grown, however, from genuine sea island seed on low-

PRODUCTION OF COTTON BY STATES

BALES

LESS THAN 100000

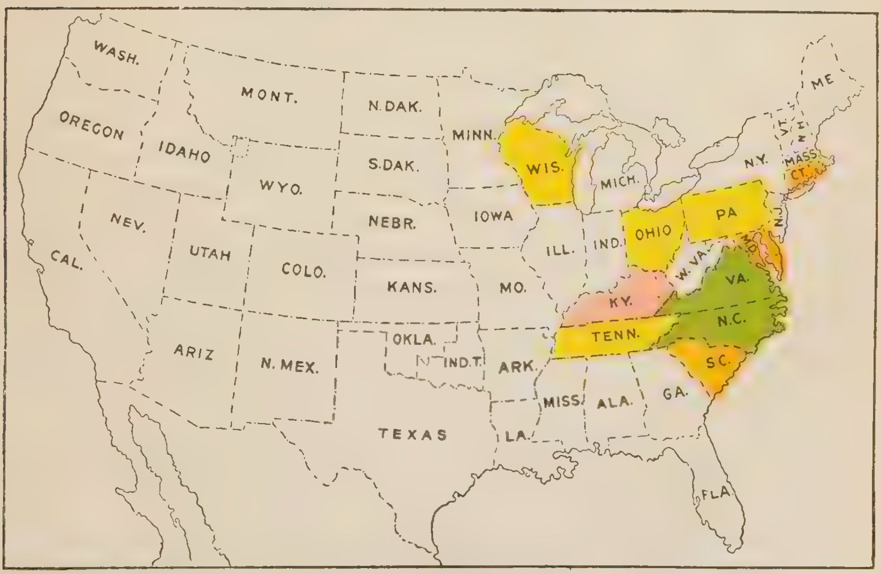
700 000 TO 1,300,000

100000 TO 400 000

400 000 TO 700000

OVER 1,300,000

PRODUCTION OF TOBACCO BY STATES.



MILLION POUNDS

LESS THAN 40

80 TO 150

40 TO 80

OVER 150

lands near the coast, where the conditions are somewhat similar to those on the sea islands, and the product is very excellent. It brings a higher price than "middling upland," and the only cotton that rivals it in the market is from Egypt; of the latter there is not nearly enough to supply the demand for long staple wool.

The by-products of cotton used to be all but wasted, the seed and stalks only being used as fertilizers by the planters. Now these products in the shape of oil, meal, hulls and linters are utilized to the value of some forty millions a year.

There has been much talk of recent years of the growing manufacture of the cotton in the south. And it has even been intimated that the increase in the number of spindles in the south was a menace to the industry in the north. Undoubtedly there was apprehension in Fall River and thereabouts, and some capitalists felt the cotton manufacturing property in New England was doomed. Such, however, was the fear of the timid and the easily scared. The cotton industry in New England is likely to keep on growing and to remain prosperous so long as the world demands such a tremendous quantity of cotton cloth. Manchester and the people of England will feel the pinch of southern competition long before Fall River and Providence. But unquestionably the south is to be congratulated on the brave start that has been made in what is in that section a new industry. There are one hundred millions of spindles in the world. Of these 17,570,000 are in the United States, and 3,500,000 are in the southern states. So we see that while in the country seventeen and one half per cent of the cotton cloth of the world is woven, that in the southern states twenty per cent of this is made. This is more than a beginning, it is a brave achievement. But it is silly and timid to have fears for New England. New England is thousands of miles nearer the cotton fields than old England, and old England last year made forty five per cent of the cotton cloth of the world, and in continental Europe thirty one and one third per cent was made. Those are the fields upon which the southern industry will encroach, if it must encroach on any. But it is likely that the increased consumption of cotton cloth will always keep up with the

increase in the number of spindles. There is no fear in the world, that is, no reasonable fear, that New England will not be able to look after herself.

The cotton crop in the United States is eleven per cent greater than the gold output of the world, and five times as great as the gold output of the United States.

To this great value, however, we must add the value of the seed products, and we have a total of something like three hundred and sixty millions of dollars. But the grand total is not yet reached, for we are working 17,570,000 spindles in the United States in making cotton cloths. The output of these, minus the cost of the raw cotton consumed, must be added before we have the grand total of the value of the product and of the industry to the people. Then again are the print works—we must not forget the print works—which decorate these cloths in such attractive fashion that they make most bewildering garments for our fair; so bewildering, that the old fashioned among us, the old fashioned just not old enough to have lived in the days of periwig and short clothes, have no more gallant comment to make on a woman who pleases them than, "She is a fine bit of calico."

THE COTTON SEED INDUSTRY.

BY CHARLES M. DAUGHERTY.

[Charles M. Daugherty, statistician; born Waynesville, Ohio, Feb. 19, 1854; educated at the University of Michigan; became connected with the department of agriculture in 1886 as editorial assistant in the bureau of statistics and later was appointed special European agent of the department with permanent headquarters in London; has made many important investigations for the department among them one into the cotton seed industry.]

Of the ordinary commercial fiber plants, cotton is the only one the fiber, or lint, of which adheres to the seed; the fiber of the others is derived from the stalk, or stem. From the cotton plant both seed and fiber are gathered by a single operation, so familiar to the colored people of the south as cotton picking; but from the other fiber plants the fiber is separated by such processes as retting and scutching, entirely distinct from that of harvesting the seed of such plants as flax, hemp, etc. From this characteristic of the cotton plant, necessitating the handling of the seed in order to obtain the lint, there have been evolved, through a slow and unforeseen course of events, two separate industries of vast economic importance. The invention of the cotton gin over a century ago had for its sole purpose the separation of the valuable lint from the then worthless seed. The marvelous effect of this invention upon cotton production and industry throughout the entire world, but especially in the United States, forms one of the most interesting chapters in the annals of agriculture. For three quarters of a century thereafter (a period, too, characterized by an ever increasing utilization of the forces of nature) cotton was raised over larger and larger areas almost exclusively for the lint, and the cotton seed remained by all odds the most important contribution of the southern states to the world's great volume of waste.

It was not until after emancipation—not, indeed, until after the cessation of the disturbed political and economic conditions of the reconstruction period in the south—that the seed of cotton was utilized to any important extent for

industrial purposes True, there is record of a mill for the extraction of oil from cotton seed at Columbia, S. C., as early as 1826; another was built at Natchez, Miss., in 1834; one is known to have been in operation in New Orleans in 1847; and a few other mills were built previous to the civil war. But as late as 1867 the slow progress that the industry had made was attested by the fact that there were only four mills actually in operation in the United States. The early operations of the new industry were carried on with the greatest secrecy, as though to guard a valuable mechanical secret, but it is now known that no radically new mechanism had been invented, as had been the case in separating the lint, for the extraction of oil from cotton seed. In the main, the machinery and principles long utilized in different parts of the world for the extraction of linseed oil from flaxseed had merely been adapted to new uses.

The cotton seed industry, at present one of the most important industries of the southern states, has, therefore, been practically the growth of the past thirty odd years. It is confined, so far as the United States is concerned, exclusively to the cotton producing states. The liability of the seed to heat or to deteriorate, if either moist or sappy, in transportation or in storage, has had a tendency to confine the erection of mills strictly within the territory where the raw material is grown; and the south has to-day a more exclusive monopoly of the manufacture of this product than of any other product of agriculture raised generally throughout that section. From 1867 to 1897, a period memorable for the awakening of industrial activity and enterprise throughout this theretofore strictly agricultural territory, some 300 cotton seed oil mills were erected throughout the south. About one third of these were built in Texas, a state where not far from a like proportion of the cotton crop is now annually grown. The remainder were distributed throughout all the other cotton producing states, the guiding purpose in construction usually being, not to embrace the apparently inexhaustible sources of supply, but rather to secure the easiest delivery of seed, either by wagon, rail, or boat, to individual mills. Among the many cities, towns, and villages

that profited from the establishment of the new industry, Memphis, Tenn., because of terminal, transportation, and other facilities, became prominent as the largest single cotton seed oil producing center in the United States, and, with one exception, in the world. The 300 mills erected throughout the south during these thirty years were generally in response to a steady increase in the variety of uses made of their products. No effort was made to create a milling capacity capable of handling more than a small, though constantly increasing, proportion of the annual supply of raw material. In fact, at the close of this period it is estimated that only about 40 per cent of the total cotton seed crop was utilized for manufacturing purposes; the remainder, save that used for seeding and feeding purposes and the modicum used for fertilizing, was consigned to waste.

The rapid growth of the industry was largely due to the great variety of uses, both edible and industrial, to which its products were found to be adapted. Cotton seed oil, like many another product of intrinsic, edible value, was first offered in a finished state to consumers under a deceptive label, bearing, in this instance, the inscription pure olive oil. Its first introduction into trade and commerce was as an adulterant; and, as is usually the case with adulterants, its own title to consideration as a product of inherent comestible value thereby became considerably impaired in the popular esteem. The exact extent to which cotton seed oil has since been used for mixing with olive oil can not be ascertained, but it is notable that when used for this purpose alone fancy prices attested its value, and attractive profits for manufacturers were a powerful impulse to increase in milling capacity and in production. Naturally, a decline in values followed, and cheaper high grade cotton seed oil, mixed with certain beef products, was found to make a profitable and valuable cooking material. A product generally known as compound lard, in which the identity of cotton seed oil was but faintly suggested in the word compound, was placed upon the market as a substitute for hog lard. Later, other like mixtures of cotton seed oil with animal fats were devised, some containing pure lard, others not, and the prin-

cipal market for this oil soon became centralized in the packing industries of the west.

It has been stated upon good authority that 30 per cent of the cotton seed oil now manufactured in the United States is purchased by packing houses, and utilized in the manufacture of various substitutes for lard. In fact, the price of this oil is now largely regulated by the fluctuations in the price of lard. Subsequent important uses to which this product has been put are as a substitute for olive oil in the packing of sardines and similar fish, as an ingredient in the manufacture of artificial butter, and for giving a natural butter color to oleomargarine. In addition to its edible uses, cotton seed oil has been adapted to many others. The residue from processes of refining and finishing the oil, and oil made from damaged seed, are largely utilized in the manufacture of a soap valuable for wool scouring and other purposes, and in extensive demand both at home and abroad. The cylinders of phonographs are also made from this residue, and an excellent laundry soap results from its combination with other greases. An oil bleached white by sulphuric acid and mixed with petroleum for use in miners' lamps is made from the lowest grades of the crude oil. Candles, glycerine, and various other products are also manufactured from oil expressed from cotton seed.

From the foregoing, it becomes apparent that the chief use of cotton seed oil is in the preparation of human food. Practically, all the high grades are utilized for edible purposes. Besides its important monopoly as a substitute for lard, it is a strong competitor in the channels of trade with oils of the olive, the peanut, and the cocoanut. On the other hand, the industrial uses of cotton seed oil are, with few exceptions, comparatively limited, or are confined to products manufactured from off-grade oil, or to the residue from refining. In the three great industrial uses of oils, illumination, painting, and lubrication, cotton seed oil is not an important factor. As an illuminant, its use is confined principally to the miner's lamp. Its deficiency in drying qualities has thus far interfered with its commercial success as a substitute for linseed oil in paint, and as a lubricant it is limited to the most ordinary

uses, no process having yet been found for eliminating the gum which makes it objectionable for general lubricating purposes. The chief industrial use of cotton seed oil is for soap making, and for this purpose it has a large domestic and foreign demand.

The by-products from the manufacture of cotton seed oil have a combined money value almost equal to that of the oil itself, but their uses are less varied. With one unimportant exception their greatest utility has gradually been demonstrated to be confined to cattle feeding. Upland cotton seed, the principal source of cotton seed oil in the United States, is covered, as delivered for the oil making process, with a fuzzy coating of short lint; for, on account of the tenacity with which the commercial staple adheres to the seed the ordinary process of ginning for the purpose of obtaining this staple fails to remove it cleanly from the seed. Upon an average, about 70 pounds of short or broken lint adheres to each ton of ginned seed. At the oil mills the first process to which the seed is submitted, after cleaning it from sand and other foreign substances, is reginning, for the purpose both of removing an oil absorbing substance and of effecting an economy in saving a part of this inferior lint. Under ordinary conditions about 30 pounds of short lint are obtained from each ton of seed. From the seed of a cotton crop of 10,000,000 bales there could thus be effected a saving, assuming that the entire crop were used, of about 300,000 bales of short lint, which at an average price of $15 a bale, would amount to $4,500,000.

The only other, but by far the most important, by-products from the manufacture of cotton seed oil are cotton seed hulls and cotton seed cake, both, the latter especially, of great economic and commercial value as cattle food. After the process of reginning, the cotton seed is run through hulling machines, which cut it to pieces and screen the hulls from the meats. Very nearly one half of the entire weight of the seed is thereby converted into the marketable product known as cotton seed hulls. In the early years of the industry this by-product was used solely for fuel, one ton of hulls being about equal in fuel value to one quarter of a ton of coal; and practically the entire motive power of the early mills was derived

from this source. In recent years the use of hulls for fuel has been totally abandoned. It has been practically demonstrated that, mixed with cotton seed meal, they are of superior value as a food for cattle, and for this purpose a steady demand now exists throughout the southern states for the entire supply. When cotton seed hulls are worth the fair price of $3.50 a ton, there would result a value of about $8,000,000 from the utilization of the possible outturn of hulls from a 10,000,000 bale cotton crop.

As is the case in the manufacture of peanut oil and cocoanut oil, only the meats of cotton seed are utilized for oil extraction. These, under ordinary conditions, constitute almost exactly one half the entire weight of the seed—1,000 pounds of meats to every short ton of seed. Their oil content naturally varies with the conditions of soil, season, etc., where the seed is grown; but, as a general rule, it is about the same as that of flaxseed. The yield of oil is, under fair conditions, about 30 per cent of the weight of the meats, or about 300 pounds of oil (40 gallons) to every 1,000 pounds of meats. The residuum, after the expression of the oil (700 pounds out of every 1,000) constitutes the well known commercial product, cotton seed cake, or, as it is called when ground for feeding or fertilizing purposes, cotton seed meal. This by-product contains nitrogenous properties of great fertilizing value, and is, moreover, when used as a mixed ration, one of the most valuable of cattle foods, containing on an average 43.26 per cent protein, 22.31 per cent nitrogen free extract, and 13.45 per cent fat. Next to the oil itself, this is commercially the most valuable product of cotton seed. It usually commands a price, pound for pound, about one fourth that of the oil; and hence the proceeds from the oil manufactured from a ton of cotton seed are, at the best, not more than double the returns from the cake. For use both as a fertilizer and for feeding purposes there has been a steady demand for this product ever since the inception of the industry. Until within the last twenty years, however, the use of cotton seed cake and meal as a cattle food was not practiced to any great extent in the United States. The bulk of these products was exported to Europe and competed suc-

cessfully in the European markets, as a cattle food, with like by-products of flaxseed. In fact, the identical uses to which cotton seed cake and linseed cake were put are suggested by the fact that previous to 1895 they were not separated in statements of exports. The early domestic demand for cotton seed cake and meal was, on the other hand, almost exclusively for fertilizing purposes, and was confined chiefly to the southeastern states, where continuous cropping of the soil had made fertilizing a necessity. But since the remarkable development of the cotton seed industry in Texas cotton seed meal, mixed with cotton seed hulls and mill feeds, has been extensively adopted as a fattening food for cattle in the southwestern states. Several hundred thousand head of cattle fattened upon this product are shipped thence each year, and its use as a feed has now become popularized to a limited extent throughout the entire south. The bulk of the cotton seed cake and meal manufactured in the United States is, however, still exported. During the past three years an average of almost three fourths of the total product has been shipped abroad. It is somewhat remarkable that the total domestic consumption of this product, as deduced from trade statistics of production and exports, shows so little increasing tendency. During the period from 1895 to 1901, the only years in which exports of cotton seed cake and meal are given separately in statements of exports, domestic consumption seems to have remained fairly steady, with no tendency to increase at all commensurate with the growth of manufacture. Evidently high prices and a heavy export demand were the primary causes of this state of the trade. There can be little doubt that there is a tendency to an increase in the use of this product in the southern states for feeding purposes, and that larger and larger quantities are annually being diverted from employment as a fertilizer to use as a cattle food. Practical economy has demonstrated that its full value is best realized in the cattle feeding industry. To indicate the possibilities in the cotton seed crop of the south it may he noted that, at the low price of $20 a ton, the cake or meal alone from the seed, if all were utilized, of a 10,000,000 bale cotton crop would have a value of about $35,000,000.

The impetus thus given to the cotton seed industry during the first thirty years of its existence has gathered even greater force within the past few years. Since 1897, 200 additional mills, approximately, have been constructed in the cotton growing states, making a total of more than 500 now manufacturing oil. Texas maintains its supremacy in the industry with a crushing capacity embracing about one third of the total number of mills. Georgia, South Carolina, and Mississippi are each of almost identical importance in the manufacture, and, combined, have about 40 per cent of the total number. Alabama, Louisiana, and North Carolina, in the order of their rank in the business, have between 30 and 40 mills each. Upwards of 20 mills are located in each of the states of Arkansas and Tennessee, and the remainder are distributed in numbers ranging from one to nine each in Virginia, Florida, Missouri, Oklahoma, and Indian Territory. Although the crushing capacity of the southern states has been increased by about one third within the past few years, the mills, during the seven months of the year in which they operate, utilize about 50 per cent of the entire crop of seed. It should be observed, however, that the increase in the number of oil mills from 1897 to 1901 has been attended and partially offset by an increase of from 25 to 30 per cent in the quantity of seed annually produced; and hence a statement of the percentage of the crop now manufactured, as compared with the proportion utilized a few years ago, falls short of indicating the true development of the industry. Commercial authorities estimate the proportion of the crop now manufactured at about 50 per cent of the gross quantity produced, against 40 per cent in 1897. But the actual quantities indicated by these percentages are 2,415,140 tons of seed manufactured in 1901 against 1,628,000 tons in 1897, an increase of 49 per cent. Nor must it be assumed that all of the large proportion of the crop unutilized for manufacture could, under any circumstances, be used for that purpose. From this surplus must be drawn for planting 25,000,000 to 28,000,000 acres of cotton—seed, it should be noted, of a somewhat bulky nature, weighing only from 30 to 33 pounds to the measured bushel, and sown by an extremely wasteful method,

an inch apart in the rows, 90 per cent of the growing plants to be afterwards chopped out in thinning. Also, the hereditary habit, among many cotton growers, of carelessly handling this formerly waste product, together with its ready susceptibility to ruinous damage from rain or moisture, doubtless unfits considerable quantities yearly for manufacturing purposes. Cotton seed in its natural state, too, is still used, perhaps to a small extent, as a fertilizer in localities remote from mills. In short, there is practical unanimity among commercial authorities that not far from two thirds of the annual cotton seed crop actually available for manufacture is now converted into oil and other products. The steady demand, both foreign and domestic, that has been firmly established for cotton seed oil, oil cake, and meal, and, more potent still, the high prices that cotton seed itself now commands in the primary markets, are influences furnishing a stimulus to this industry that doubtless will very soon result in the manufacture of every available pound of cotton seed raised in the southern states.

The benefits accruing to the country from this industry are of a diversity that can scarcely be conceived. In it a capital of over $100,000,000 has been invested and distributed throughout the southern states. As a result, good markets now exist in hundreds of southern cities and towns for an agricultural product that within the memory of middle aged men was notable chiefly for its unadaptability to profitable uses. Tens of thousands of laborers, almost exclusively of the resident negro race, now find employment in the manufacture of cotton seed oil and in the various occupations directly incident to the industry. In the two chief products, oil and oil cake, or meal, a foreign export trade has been established that returns to the south annually from $25,000,000 to $30,000,000, and the domestic trade is not greatly inferior. Naturally, allied industries have sprung up near the sources of supply for their raw material. Fertilizer factories, utilizing cotton seed meal as a source of nitrogen in mixing fertilizers, effect economies by combining with or locating near the oil mills. Cattle feeding, especially in the states west of the Mississippi, has been found by cattle feeders

a profitable adjunct to the mills, and is practiced on a large scale. Oil refining, which was formerly done almost exclusively by the western packing houses, the crude oil being shipped thither from the south, is now carried on extensively by the oil mills themselves. The grinding of oil cake into meal, in a manner an allied industry of oil making, is also largely confined to the cotton seed oil mills. It is notable, too, that, in the trend of modern business methods, combinations of the capital invested in this industry have been made for the purpose of effecting economies in the manufacture from the raw material and of regulating trade in the manufactured products. Uniformity of prices has been established throughout the south for a product of the cotton fields that, even a few years ago, was valued, according to locality, either by the whim of the purchaser or by the keenness of competition. Cotton seed is now quoted, bought, and sold on southern cotton exchanges after the manner that grain is on the boards of trade and produce exchanges of the north and west. In fact, the cotton seed industry, originally based upon the chance discovery that a cumbersome and unsalable by-product of the cotton belt was rich in oil valuable chiefly for adulterative purposes, has now been transformed into a separate, distinct, organized business, and its manufactured products are sold extensively, both in foreign and domestic markets, on their own merits, for a great variety of purposes. The cotton seed crop is now an important entity in the agriculture of the country, and has the distinction of being the most valuable oleaginous seed crop produced in the United States

The census investigations disclosed the fact that 53.1 per cent of the cotton seed crop of 1899–1900 was utilized in manufacture; the average yield of oil per ton of seed manufactured for the entire country during that year was 37.6 gallons; the yield of oil cake, 713 pounds per ton. These figures indicate that the commonly accepted commercial estimates upon this industry for previous years were fairly close approximations.

The United States, though not possessing a monopoly of the manufacture of cotton seed oil and oil cake, practically

controls the world's trade in these products. No other cotton producing country is engaged to any noteworthy extent in this industry; and attention has already been called to a perishable quality of cotton seed that tends to limit its use for manufacturing purposes closely to the countries where grown. It happens, however, that the lint of the long staple cotton grown in Egypt, like that of the sea island cotton of the United States, does not adhere tenaciously to the seed; it is completely removed by the ginning operation, leaving the seed smooth, lintless, and, hence, less liable to heat and damage in storage or in transportation than is the upland cotton seed of America. This characteristic of the Egyptian seed had made possible the profitable establishment of cotton seed oil mills in England and France long before the industry had assumed importance in this country. Until about 1880, England, though crushing then only about 200,000 tons of seed annually, was the leading cotton seed oil producer of the world; in fact, as late as 1890, the quantity of cotton seed crushed in England was 43 per cent of that crushed in the United States. The liability, however, even of lintless seed to heat and to deteriorate in the holds of vessels is, with other causes, likely to prove a permanent obstacle to further important extension, in non cotton producing countries, of this trade. The English mills are now about twenty five in number, three fourths of them located at Hull, the largest single cotton seed crushing center in the world. These mills, all told, utilize about 400,000 tons of seed annually, 85 to 90 per cent of it being drawn from Egypt. Also, practically all cotton seed exported from the United States, amounting, however, to only 15,000 to 20,000 tons annually, is taken by the English mills. In France, the cotton seed industry is confined to the city of Marseilles, where the five mills now in operation crush annually from 40,000 to 50,000 tons of seed. The French mills, as is the case with those in England, draw their supplies of raw material principally from Egypt, and crush seed without decortication, thereby producing an oil inferior to that produced in the United States from seed fresh from the fields; the mills in France also refine large quantities of American oil. The weakness of foreign competition in this

industry, however, is indicated by the fact that the English and French mills, combined, crush annually less than one fourth the quantity of seed crushed in the United States.

The consumption of cotton seed oil in the United States is greater than that of any other single country. In recent years it has averaged over 40,000,000 gallons annually. Domestic consumption, however, does not seem to be greatly increasing, and the heavy increase in production has been absorbed chiefly by the foreign demand. Notwithstanding the large quantities required for domestic uses, about one half of the oil manufactured in this country is now exported; and from 85 to 90 per cent of the exports are for European destination. France and Holland, combined, have for many years taken, as a general rule, about one half the total quantity exported—the former, large quantities of low grade oils for refining, or for use in soap manufacture, also some high grades for various edible purposes; the latter, chiefly high grades of summer yellow or butter oil for the manufacture of artificial butter. In the order of their importance as purchasers the position of these countries has in recent years been reversed. For some years previous to 1896 Holland's takings were about treble in quantity those of France; but, since that date, though the trade of each has greatly increased, that of France has advanced with giant strides, and now absorbs annually about one third, whereas Holland takes but from one fifth to one sixth of our total exports. The increase of the trade with France, though it declined somewhat in 1900, has been the most striking feature in the history of our European commerce in this product. Austria-Hungary, Germany, and the United Kingdom are next in importance as purchasers, taking together, however, less than 30 per cent of the total exports, or, something over 4,000,000 gallons each. The only other European customers of notable importance in this trade are Italy and Belgium, whose takings in one year amounted, respectively, to 2,660,000 and 1,915,000 gallons. An export trade in this product, moreover, is now carried on on smaller scales with various countries of all continents, and the total exports of cotton seed oil from the

United States for the past three years have averaged, in cash value, $14,000,000.

One of the most notable features of the cotton seed oil industry is the limited consumption in the United States, as compared with that in certain European countries, of cotton seed oil cake and meal as a cattle food. Although considerable quantities of this product are now fed in some sections of this country, only about one fourth of the quantity manufactured in the United States has been retained for home consumption; moreover, a large proportion of this, possibly one half, has been utilized for mixing fertilizers. The remaining three fourths have been exported, and of these heavy exports, three countries of Europe have taken about 85 per cent. Germany, the principal customer for this product, has alone drawn a larger quantity from the United States than they themselves consumed. England, whose finely bred herds consume a larger quantity of cotton seed cake and meal than do those of any other country on earth, supplements her own supplies annually by drafts upon the United States amounting now in quantity to over three fourths of our own consumption. Denmark, the fame of whose dairy industry is world wide, shows a growing appreciation of this valuable animal food, and her takings from the United States have increased from 10,000 tons in 1896 to 137,000 tons in 1900. Holland and France, though comparatively much less important as customers, complete the list of European countries participating to noteworthy extent in this trade. The principal cisatlantic participants in the small balance of the trade are the Dominion of Canada and the West Indies. The value of the total export trade in cotton seed oil cake and meal for the past three years has averaged $11,000,000 per annum. Notwithstanding the high prices that this product now commands, its greatest economic value would undoubtedly be realized by larger use as a domestic cattle food, thereby not only realizing its full value as a feed, but also returning its rich fertilizing properties to the soil.

The foreign demand for both cotton seed oil cake and meal and linseed oil cake and meal—identical products so far as their uses as food are concerned—indicates a much

greater appreciation of their economic value abroad than is apparent at home. The combined exports of these commodities constitute in money value the most important item of animal food, with the exception of corn, shipped out of the United States. And whereas the annual exports of corn have at the maximum never exceeded 11 per cent of the crop, the popularity of these oil seed products upon foreign markets is attested by the fact that of late years from 60 to 75 per cent of the entire quantities annually manufactured have been sent abroad.

COTTON MACHINERY.

BY DANIEL C. ROPER.

[Daniel C. Roper, statistician and agricultural expert; born Marlboro county, S. C., April 1, 1867; graduated from Trinity college, and the National university, Washington, D. C,; has been a member of the South Carolina legislature and later clerk for the committee on interstate commerce of the United States senate; appointed expert special agent in the census bureau and had immediate direction of the investigations into the cotton and rice industries at the twelfth census.]

Early settlers north of the Ohio river planted cotton for domestic uses between 1849 and 1880. The census of 1860 found in Illinois 1,482 bales, or 659,490 pounds of cotton. Stimulated by the high prices following the Civil war, the cultivation of cotton was conducted to a limited extent in California, Illinois, Indiana, Nevada, Utah, and West Virginia. With the coming of low prices cotton culture gradually disappeared from these sections not peculiarly adapted to it, and censuses after 1870 credited none to California, Illinois, Indiana, Nevada, Utah, or West Virginia. Natural selection continues to eliminate the industry from sections less favored by climatic conditions. To illustrate, Kentucky is credited by the censuses of 1880 and 1890 with 1,367 and 873 bales, respectively, but at the census of 1900 the ginners reported for that state only 84 bales.

The loss of these states lying along the northern border of the cotton belt is more than offset by the increase found in the territory west and southwest of the Mississippi river. According to the eleventh census, 2,872,524 bales, or 38 per cent of the entire American crop of 1889, was grown in that region, while in the census of 1900, in the same territory, the production, according to the ginners, reached 4,250,940 bales, or 45 per cent of the whole crop. This increase was practically confined to Texas, Oklahoma, and Indiana Territory, Texas alone producing 28 per cent of the entire cotton crop. The census of 1890 credited the Indian Territory with 34,115 bales and Oklahoma with 425 bales. The census of 1900 gave

these territories respectively 143,608 and 71,983 bales (500 pound standard).

Prior to the invention of the cotton gin by Eli Whitney in 1794 the separation of the seed from the lint cotton was so difficult as to limit the cultivation of cotton. This separation of the seed from the lint had to be done by hand, a task being 4 pounds of lint cotton per week for each head of the family, working at night in addition to the usual field work. Thus it would take one person two years to turn out the quantity of cotton contained in one average standard bale. One machine will gin from three to fifteen 500 pound bales per day, dependent upon its power and saw capacity. While several machines had been invented for the seeding of cotton, it was reserved for Eli Whitney to inaugurate, by his invention, the era which was to perfect the industry of cotton ginning and revolutionize the culture and commerce of the staple.

The primitive saw gin was operated by hand and of necessity exceedingly limited in capacity. The first very substantial advancement, resulting from years of research, was the horsepower attachment for ginning and baling, which brought the old fashioned cotton ginnery and screw. The motive power for this ginnery consisted of two, four, or more horses or mules. The cotton was hauled in wagons to the gin house, unloaded by hand into bins, carried again by hand to a platform, and thence fed by hand into the gin. By the old fashioned ginnery and screw the lint cotton was blown by a brush from the saw gin into a lint room, where it was often allowed to accumulate, awaiting a rainy day or other opportune occasion for baling. It was then conveyed in baskets or sheets to the single press box of the old wooden screw, which was located some 30 or 40 feet from the ginhouse. There it was dumped into the box and trampled by foot until a sufficient quantity was inclosed to make a bale. By means of a horse at the lever or wing of the press the follow block, upon which the screw was pivoted, was forced down or up, as the case might be, until the desired bale density was attained. Jute bagging was generally used as a wrapping, and the shape of the bale was preserved, at first by the use of rope, and later by means of iron bands, called ties.

A few of these landmarks are yet found throughout the country, though they are now curiosities. It is scarcely necessary to say that this old method of handling cotton at the gin was exceedingly laborious, wasteful, and unhealthy, and that nothing but cheap labor and high prices for the staple allowed it to continue as long as it did.

Much time, labor, and money have been expended in efforts to combine ginning and baling plants, to the end that greater speed might be gained, labor economized, and other desired reforms attained in handling seed cotton. The outcome is automatic ginneries, practically doing away with labor, and yielding from five to ten times as much lint cotton per day as was possible by the earlier processes.

A modern ginnery containing 4 gins of 70 saws each with a double square bale press and suction apparatus attached requires an 80 horsepower engine. Such a plant in constant operation will yield from 40 to 60 bales of cotton per day. The wagon, loaded with seed cotton, is driven under a flexible slip of a joint pipe, and the cotton is drawn up by suction created by an exhaust fan which is connected with the rear of the vacuum separator and cleaner. By this separator and cleaner the dust, sand, and leaf trash are sifted and drawn through by suction, and thus freed from impurities the cotton is conveyed through a distributer to the automatic gin feeders. After filling all of the feeders the surplus cotton falls out at the end of the automatic tube and drops upon the floor or into a bin. When the cotton is all out of the wagon or bin, as the case may be, the ginner by means of a simple lever, causes the suction to change from the direction of the wagon to that of the overflow, and the overflow cotton is conveyed to the gin feeders. From all the gins the cotton is conducted by a flue system to a condenser, and fed into one box of the self packing revolving double press. In this way lint is ginned into one box while the bale is being pressed out of the other. Thus, the cotton need not be touched by hand from the time it leaves the wagon or bin until it is delivered, a perfect bale, upon the platform where it is loaded ready for market.

Thus, from the hand seeder, yielding about four pounds of lint cotton per week, advance has been made to the saw

gin, which, with a 40-saw capacity and horsepower, yielded about 2,000 pounds per day, and finally to the complete battery ginnery, carrying in some instances as many as 15 70-saw gins, operated by steam and having a possible capacity of 150 bales, or 75,000 pounds, in twelve hours. The condenser and automatic press feed have superseded the old wooden screw. The laborious handling of the seed is avoided, it being blown either into a distant seed room or into the waiting wagon of the owner. In this way the life and value of the seed are preserved in conformity with the requirements of the oil mill. Thus, the arduous labor heretofore attached to the cotton ginnery has been wonderfully reduced, and life, limb, and property marvelously protected.

Possibly no invention ever caused so rapid a development of the industry with which it was associated as that brought through the saw cotton gin. In 1793 the exportation of cotton from the United States was 487,500 pounds, or 975 bales of an average weight of 500 pounds. In 1794, the year in which the Whitney gin was patented, the number of pounds of cotton exported from the United States was 1,600,000, equivalent to 3,200 bales of a 500 pound standard. This large production so frightened the cotton farmers, in anticipation of an overproduction of the crop, as to cause them to pledge themselves to desist from its production. And yet within one hundred years, 1800 to 1900, the production of cotton in the United States has increased from, approximately, 80,000 to 9,345,391 bales, 500 pound standard.

The art of pressing cotton has presented to inventors unusual difficulties. Among the recent and more economic methods of baling cotton is the introduction of a bale of uniform size and weight, and possessing greater density. With many of those who advocate the square bale there is a belief that the density of that package may be so increased as to avoid the present necessity of recompression. Already inventions have been made promising this result. The present accepted square bale of commerce is 54 inches in length, varying in breadth from 24 to 27 inches, and pressed down to a thickness of 28 to 30 inches.

Out of the efforts to devise superior systems of preparing lint cotton for market have come a great number of inventions for producing packages of various shapes and weights. But of the scores of presses invented for baling cotton in cylindrical form, there have been only two put into practical operation. By one of these the lint, as it comes from the gin, is blown into a storage reservoir and bat former, where it is converted into a continuous bat of even thickness, and wound around a cone under a pressure which, light at first, is gradually increased automatically by two rollers operating at opposite sides, until the bale attains its full density. By this steady exertion of an even pressure gradually applied to all the cotton in detail, bales are produced 22 inches in diameter, and 35 and 48 inches in length, weighing on an average 270 and 425 pounds, respectively. The bales require no further compression, as they possess a density of 35 pounds per cubic foot as compared with a density of 22.5 pounds in the old compressed square bale. This package is self containing, holding its form and density by adhesion of fiber to fiber and layer to layer, thus avoiding the necessity of iron bands to preserve its shape. The first round lap bale press was set up in the United States in 1894. Its product was much heavier than the present bale, reaching as great a weight as 500 pounds.

The other round bale press which has come into practical use consists in feeding the lint cotton loose from the gin into a tube surrounded by a cap plate with a number of slots therein radiating from the center to the circumference. The bale is first started in the tube by packing cotton therein by hand. When this is done, and a relative revolution of the cap plate and tube is established, the loose cotton thrown on top comes in contact with that inside the tube and is drawn in through the slots, and the bale is thus built up endwise. In the first named system, pressure is applied from end to end of the bale at two points along the outside circumference, while in the second system pressure is applied only to the end of the bale. The bale turned out by this press, in its earlier history, like that of the first mentioned press, reached a weight of 500 pounds, but with this press also there has been a gradual

tendency toward the lighter weight package, until at this time the average weight of the bale of its new pattern is but 250 pounds. The bale is of uniform size, 18 inches in diameter and 36 inches in length, and possesses a density of about 45 pounds per cubic foot, against 22.5 pounds attained in the compressed square bale.

It is interesting to note that this press is being advantageously employed for baling hay and other fibrous commodities. There have also been other more or less successful experiments in ginning cotton with the device, converting the press into a roller gin.

THE FUTURE DEMAND FOR AMERICAN COTTON.

BY J. L. WATKINS.

[James Lawrence Watkins, cotton statistician; born Pulaski, Tenn., October 21, 1850; educated at Virginia Military institute, Lexington, Va.; was superintendent of Education, Madison county, Ala., supervisor of Eleventh Census, and now Cotton Expert, United States department of agriculture. Author: The Price and Production of Cotton for 100 years, The Cost of Cotton Production, The Future Demand for American Cotton, Consumption of Cotton in the Cotton States, Cotton and the Currency.]

When cotton culture on an extensive scale was first undertaken in this country, wool and flax as a material for clothing were far more popular than cotton, at least in the western world. For centuries millions of the inhabitants of Oriental countries had been clothed in homespun cotton, and the hand looms of India had woven calicoes and muslins of such beautiful design and exquisite texture as to challenge universal admiration.

But it was not until the planters of the United States began supplying an abundance of raw material, much cheaper than wool or flax, that European nations recognized its merits and its possibilities in textile manufacture. If we go back just a few years beyond the date of the invention of the saw gin (1793), we find that in Great Britain, which then led the world in textile manufactures, wool held the first place in the value of its textile industries, linen the second, and cotton the third. In fact, the value of cotton fabrics and yarns amounted to only about 5 per cent of the whole. Ten years later cotton took the second rank in the value of the textiles exported from Great Britain, but in another ten years it took the lead, and went on steadily gaining ground until it attained the first place, not only in respect of exports, but also in respect of the weight and value of fabrics consumed at home.

A complete revolution took place in the consumption of textile fabrics after 1800. More flax was then used than either wool or cotton, but it has now dropped to the third rank, and the amount consumed is barely double that of a hundred years

ago. Wool has increased nearly five times, while cotton has increased nearly thirty nine times, and there is now more than three times as much cotton used as wool, and more than seven times as much as flax.

As to what is the relative proportion of cotton, wool, and flax consumed the world over, there is no means of knowing, because there are no such statistics available. But we do know approximately the quantity of each fiber that enters into the commerce of the world. As flax is practically out of the race as a successful competitor of cotton and wool, the next question of interest is, how does the competition stand between the latter two fibers? This is best illustrated by showing the total world's supply of each. But in presenting these figures it should be understood that they do not represent the world's production of either cotton or wool, but the supply that enters into the world's commerce. Nor is it necessary to go beyond the year 1870, for it was about that time that cotton production in the United States began to assume something like the importance it held prior to the civil war. The following table gives the figures in decennial years, in thousands of pounds.

COTTON AND WOOL IN THE WORLD'S COMMERCE IN DECENNIAL YEARS.
[In thousands of pounds.]

Year.	Cotton.	Wool.
1870	2,483,600	1,295,000
1880	3,605,200	1,626,000
1890	5,228,000	2,456,774
1900	6,796,500	2,685,105

It will be seen that from 1870 to 1880 the commercial supply of cotton increased 45 per cent, while that of wool increased 26 per cent. In the next decade there was a gain of 45 per cent in cotton and 51 per cent in wool. In the last decade, from 1890 to 1900, the gain in cotton was 30 per cent and that in wool only 9 per cent. Taking the entire period of thirty years, from 1870 to 1900, the increase in the supply

of cotton was 174 per cent and in that of wool 107 per cent.

Having shown the relative position held by the three leading fibers that supply the world with raw material for its clothing, and having noticed the extraordinary expansion in the production and consumption of cotton, the questions naturally occur: To what is it due? Is cotton taking the place of wool and flax and other fibers?

The "decline and fall of the linen shirt" is the significant title of an editorial that appeared in the Irish Textile Journal, a publication devoted to the British linen trade. There was once a time, it says, that the people of Brittany were found to have a linen standard by which the different grades of society could be recognized at sight, and a well filled linen chest was reckoned as a leading item in family wealth. But the decay of the linen trade has been rapid enough to be within the remembrance of those still engaged in the business, and leading shirt makers could furnish a deplorable list of influential people who have, to their knowledge, given up buying full linen shirts. According to this authority, the Rothschilds used to order, on occasion, a supply at prices up to $3.75 a shirt, whereas those now required for the duke of York, and other royalties, are turned out at Belfast with only fronts and cuffs of linen, the bodies of cotton. This advocate of the linen trade has no fault to find with cotton, as cotton, but pities the manufacturer for allowing linen to slip off the backs of men without some effort to keep it in its former place.

In regard to the wool industry, the condition of affairs seems to be even worse than with that of linen. In fact, the situation has become so acute that the wool growers have taken a hand in the struggle, and an organization has been perfected for the purpose of appealing to congress to enact legislation compelling the manufacturer to brand his goods so as to distinguish cotton mixed fabrics from all wool fabrics. Of course, all industries have their periods of depression, the cotton industry as well as others, but that of wool seems to have been undergoing a prolonged depression such as has not affected other branches of trade. This depression is not con-

fined to this country, but extends to Great Britain and the manufacturing districts of France and Germany as well.

In Great Britain many firms have gone out of business, and in France some have changed their machinery to that for the manufacture of cotton.

Various reasons are assigned for this state of affairs, such as overproduction, high prices of raw materials, etc., but all authorities agree that one of the principal causes is the competition of cotton. "The use of cotton goods as a substitute for woolens," says the Bulletin of the National association of wool manufacturers, "has been increasing of late years. The advance which the cotton manufacturer has made in the direction of imitating various makes of woolens has been very great in ten years. So also has been the use of cotton in connection with wool. Even with cotton at 10 cents a pound the difference between its cost and that of wool at 50 cents a pound is so great in these days as to encourage the use of more or less cotton in fabrics which will not command prices which allow a fair return provided the material used were all wool." "The extension of woolen mills can not be advanced as a cause of the depression in the woolen and worsted industry," says the Textile World, "for there has been no increase in machinery such as we have seen in the cotton industry; the growth of our woolen and worsted mills has not kept pace with the growth of the country's population." The per capita consumption of raw wool in the United States in 1870 was 5.43 pounds, and in 1900, 5.72 pounds, and in 1904, 5.66 pounds. The per capita consumption of raw cotton in 1870 was 12.82 pounds, and in 1900, 22.57 pounds, and in 1904, 25.28 pounds. One of the causes of the change is the increased use of cotton where formerly wool was the material required, the advance in the arts of coloring and designing cotton fabrics having made this substitution of cotton possible.

Nor has cotton spared its opulent and disdainful rival, silk. For a long time it has been known that silk manufacturers have used cotton for mixing with certain kinds of satin and other silk fabrics. Some of the foreign made silks are heavily weighted and so mixed with mercerized cotton that

it is difficult sometimes to find the silk. Not only is cotton being extensively mixed with silk, but fabrics made from mercerized cotton yarns have entered the markets in competition with a certain class of silk goods. "The manufacture of mercerized cotton fabrics," says the Irish Textile Journal, "has reached such proportions that these goods have taken apparently a permanent position among the textile standards, and it is reasonable to presume that the position they occupy will be held for many years, or until some other fiber modification will have been discovered that will come closer to silk. At the time mercerized threads were noticed the general opinion was that the new article would find only limited application among a few unimportant classes of goods, but as the properties became better known other openings were found, so that to-day there is hardly a fabric where silk is employed but that mercerized cotton can, to a certain extent, displace it—from draperies and hangings, linings, etc., to neckwear and hosiery." A German chemist has invented a method of making an artificial silk from raw cotton which, it is said, far exceeds the ordinary mercerized cotton. The product is reported to be brilliant in color and finish, of considerable textile strength, and sells for about 60 per cent of the value of real silk.

So much for the competition of cotton with its three rival fibers, wool, linen, and silk, and the great revolution that has been wrought in the textile industries. And for this revolution, resulting in such a great reduction in the price of clothing, the world is largely indebted to the cotton planters of the United States. We do not forget the world's indebtedness to the English inventors, Hargreaves, Arkwright, Crompton, Cartwright, Watt, and Roberts, and to our own Eli Whitney; nor do we overlook the ceaseless enterprise of British spinners and the indomitable push of British merchants. But while they invented wonderful labor saving machines, wove their cotton into the best and cheapest of fabrics, and sent them into the remotest markets of the earth, the southern planter was felling the forests of Alabama, Mississippi, Arkansas, and Texas, opening up new plantations on river side and prairie, and sending to market ever increasing supplies of the fleecy

staple. Nor has there ever been a time, excepting the four years of the civil war, that they did not keep the spinners of the world abundantly supplied with the very best raw material, and at reasonable prices.

About the time of the invention of the saw gin (1793) European spinners obtained their supplies of raw cotton from the West Indies, Turkey (Smyrna), and Brazil. But the chief source of supply was the West Indies, those islands furnishing about 71 per cent, Turkey 20 per cent, and Brazil about 8 per cent. However, the supply from the West Indies began to diminish almost from the date that American cotton assumed importance in the Liverpool market, and by 1816–1820 the contribution from this source amounted to less than 7 per cent of the total supply. After 1836–1840 the supply from the West Indies became insignificant, and has remained so up to the present time, not even the high prices of the civil war stimulating production to any appreciable extent.

The supplies from Brazil gained ground until 1826–1830, but during the subsequent thirty years fell behind, and in 1856–1860 averaged only about the same as in 1816–1820. The civil war increased the crop considerably, but the increase was lost on the return of a lower range of values in 1876–1880. In 1893 the exports from Brazil amounted to 165,000 bales, and in 1900 to only 108,000. During other recent years the exports have been very much smaller. This is perhaps largely due to the fact that the domestic consumption is increasing, as cotton manufacturing has made considerable progress in that country in recent years.

As to the contribution of the East Indies to the world's supply of cotton, a country that for a long time was considered a dangerous rival of the United States, Mr. Thomas Ellison, a statistician of Liverpool, tells us that up to the time of our civil war it was the current opinion, both in England and in India, that the cotton crop of that country was equal to 5,000,000 to 6,000,000 bales of American weight; some authorities, indeed, went so far as to estimate the yield at 10,000,000 bales. But the fact that the extraordinarily high prices current during the civil war failed to raise the import into Europe to more than 1,374,000 bales against 949,000 in

1861, was a proof that the crop could never at any time have reached one half of the smallest previous estimates. Mr. Ellison doubted (this was in 1886) whether the crop ever exceeded 2,500,000 bales. The records show that Mr. Ellison was very nearly correct, for, so far as known, the crops of that country, as indicated by the exports and domestic mill consumption, have rarely ever exceeded 3,000,000 bales of 400 pounds, and the average annual crops are far below these figures. Among the noteworthy changes that have taken place in the cotton trade of the east is the decline of the exports of raw cotton from the East Indies. In 1871–1872 the exports to Europe amounted to over 2,000,000 bales of 400 pounds, in 1889–1890 to 1,510,000 bales of 500 pounds, and in 1900–1901 to only 848,000 bales of 400 pounds. It is a quite noticeable fact that in recent years Italy, Belgium, Austria-Hungary, France, and the united kingdom have each been taking less and less East Indian cotton. The falling off of imports into the United kingdom is remarkable. Not very many years ago English spinners consumed over a half million bales, but now the consumption is almost insignificant. And every pound of East Indian cotton displaced means its replacement by a pound of American cotton of better quality.

To what extent the decline in the exports of cotton from India to Europe is due to the increase in domestic consumption and to exports to Japan (which country has of late largely increased its purchases of Indian cotton), and to what extent it is due to the cheapness and superiority of American cotton, is an interesting subject for investigation. It can only be partially due to increased home consumption, because in some years there have been ample surplus stocks for export. The director general of statistics to the government of India, in the Review of the Trade of India, a few years ago, attributed this decline to the fall in the price of American cotton caused by unusually large crops, and this explanation seems undoubtedly correct.

The cotton supply from Egypt has gradually increased from the date of its introduction in lower Egypt in 1820, but the great development of cotton culture in that country began with the cotton famine of 1861–1865. In 1860 the government

reduced the export duty from 10 to 1 per cent, and this also stimulated the culture, and the annual average export for the decade 1861–1870 was 310,000 bales of 400 pounds. Unlike other cotton growing countries, Egypt did not reduce its production upon the resumption of shipments from America after the civil war, but has steadily increased its output.

But the Egyptian cotton can hardly be considered a rival of the upland staple of America. It is more like our sea island cotton, although not as fine, and is used for fabrics requiring a smooth finish and silky luster. Moreover, most of it is of a light brownish hue, and among spinners is considered a specialty. Perhaps the best evidence of this lies in the fact that our own spinners annually import large quantities of Egyptian cotton. The imports in 1900–1901 amounted to 69,471 bales of 500 pounds.

Since 1870 the increased consumption on the continent, in the United States, and in India has been enormous. It has also been very large in Great Britain, though much less than in the United States and Germany. Indeed, the United States is now the largest cotton consuming country in the world, having in 1898 taken the lead from Great Britain, which had held the supremacy in the cotton industry for over a century. Undoubtedly this expansion could never have have taken place (outside of India) except for the continually increasing crops of the southern states. We are supplying the world with more than 85 per cent of the cotton it manufactures into clothing, and when our crops were very much smaller than now, the cotton crops of the United States provided the raw material for more than half the calico used by the entire human race. Mr. Wu Ting-fang, the Chinese minister to this country, in a recent interview stated that until within the past few years his people made all the material for their own shirts, but owing to the cleverness of American manufacturers, China was being supplied with shirt stuffs superior to its own. Consequently, these goods have crowded out those of China, and not only do the well-to-do, but the poor also, wear American shirtings, and no matter how far you travel into the interior, you will see natives, who never laid eyes on a foreigner, clad in shirting from the United States.

In further illustration of the demand for American cotton, the following figures are presented with the view of showing the comparative consumption in each foreign country in 1870, 1900 and 1904. The figures are in uniform bales of 500 pounds each.

EXPORTS OF COTTON FROM THE UNITED STATES IN 1870 AND 1900.
[In bales of 500 pounds.]

Exports to	1870.	1900.	1904 in pounds.
Austria-Hungary (for 1871)	4,330	44,919	14,079,167
Belgium	3,452	148,319	52,606,669
Denmark (for 1869)	212	31,990	14,574,715
France	306,293	736,092	367,142,936
Germany	173,552	1,619,173	898,676,674
Italy	14,549	443,951	181,647,582
Netherlands	17,050	74,635	8,021,551
Portugal (for 1871)	346	18,472	5,949,404
Russia	30,341	54,950	84,252,929
Spain	55,409	246,612	92,431,090
Norway and Sweden	13,774	14,773	9,716,554
United Kingdom	1,298,332	2,302,090	1,237,876,137
All other Europe	1,620	400	502,952
Total Europe	1,919,260	5,736,376	2,967,484,360
British North America	3,122	109,983	44,397,583
Mexico	13,219	18,522	28,085,870
South America	177	219	....
Japan	....	323,202	22,934,678
All other countries (for 1871)	1,263	12,826	290,269
Total	1,937,041	6,201,128	3,063,192,760

It will be observed that without a single exception every foreign country has increased its consumption of American cotton, and some of them to astonishing proportions. This is true particularly of Germany, Italy, France, Belgium, Spain, and Japan. But the most astonishing development of our trade in raw cotton has taken place in the far east. In 1870 we did not ship a pound of cotton to that part of the world, but since then cotton manufacturing has made great progress in Japan. East India and China also appreciate the merits of our cotton, and shipments have been made to both of these countries.

Much has been said about the increase in the culture of cotton in Asiatic Russia and the consequent falling off in the exports of American cotton to that country; and it is true that we formerly exported directly to Russian ports some 300,000

bales per annum. But in spite of the fact that in July, 1900, the Russian government raised the import duty on raw cotton to $28.87 per bale of 500 pounds, or almost the value of the cotton, we still furnish that country with about half the cotton used in her mills. The exports do not indicate this, for the reason that Russian spinners for some cause or other prefer to buy their supplies of American cotton from Liverpool brokers. Besides the shipments from Liverpool by water, government statistics show that in 1900 there were imported into the empire by overland routes, via Alexandrova, Sosnovice, Wirballen, Mlavo, and Graievo, 109,615 bales of cotton of 500 pounds, nearly, if not quite, all of which was grown in the United States.

The consumption of cotton has increased so greatly within the past quarter of a century that there would appear to be no limit to its future possibilities. It is estimated that of the world's population of 1,500,000,000, about 500,000,000 regularly wear clothes, about 750,000,000 are partially clothed, 250,000,000 habitually go almost naked, and that to clothe the entire population of the world would require 42,000,000 bales of 500 pounds each. It therefore seems more likely that the cotton industry will go on expanding until the whole of the inhabited earth is clothed with the products of its looms. This is not an unreasonable conclusion when we consider the fact that cotton is the cheapest material for clothing known to man. In the meantime it may come to pass that the world's area suitable for cotton culture may have to be seriously reckoned with, just as was the case during the civil war.

For some years prior to the outbreak of the civil war it had been foreseen that sooner or later a serious labor disturbance at the south was inevitable, and in view of the calamity which such an event would bring upon English spinners, every effort was made to discover new sources of cotton supply. But although the powerful association formed for the promotion of this end searched every nook and corner of the cotton zone, and sent seed to every one in the four continents willing to make experiments, they entirely failed to accomplish the object they had in view. The high prices caused by the famine brought increased supplies from Brazil, Turkey,

India, and China, but with the return of ante war values the imports into Europe fell back almost to the level at which they stood in 1860–1861, and with the exception of Egypt there has been no substantial increase in the supplies from any country since 1865; hence European spinners are to-day more than ever dependent upon the planters of the United States.

But when the requirements of the world reach from 35,000,000 to 40,000,000 bales, will the southern states be equal to the emergency, as they were after the civil war? Will they continue meanwhile to retain supremacy in cotton production? We have every reason to believe that they will. Their most dangerous rivals are India, Russia, Brazil and Egypt.

India has already been put to the test, and, besides, her own mills are now taking a large and increasing proportion of her crops.

Russia is making rapid progress in cotton production in her trans-Caspian provinces, but considerably more than half her mill consumption is still of foreign growth, and it will be a long time before she can become entirely independent of a foreign supply. As for any surplus being marketed from that region, the possibility is too remote to be considered.

Cotton culture in Brazil could be greatly extended but for the lack of sufficient labor; moreover, her planters find more profit in coffee culture.

It is estimated that when the irrigation works now under construction on the lower Nile are completed a little more than 1,000,000 acres will be reclaimed and brought under cultivation, most of which will be devoted to cotton. This will increase the crop to about 2,000,000 bales of 500 pounds. Even should the entire available area in upper and lower Egypt be devoted to cotton, at the present rate of production the crop could not exceed 3,750,000 to 4,000,000 bales of 500 pounds. This is the limit of production in Egypt. Under ordinary conditions (for necessarily a large area must always be planted in grain and other food crops), and after the irrigation works are completed and put in operation, Egypt can not supply the world with more than about 2,000,000 bales of 500 pounds.

Africa is an inviting field for the growth of cotton, and experiments are being made by the French and Germans in the Soudan, but on a very small scale, and the English are endeavoring to introduce it in Sierra Leone. But whatever may be the possibilities of growing cotton in this part of the world, it is yet an unsettled wilderness, and it will be many years, perhaps a century or more, before any substantial progress can be made toward the production of cotton on a large scale.

Where, then, are the spinners of the world to look for an increase in the supply of raw cotton?

Oklahoma and the Indian Territory are each much larger in area than South Carolina, and this state in 1897 and 1898 produced over 1,000,000 bales of cotton. Under favorable conditions, therefore, these territories could safely be counted on to supply 2,500,000 bales.

The Atlantic states—Virginia, the Carolinas, Georgia, and Florida—could increase their yield by 1,000,000 bales, and the gulf states, exclusive of Texas and including Arkansas, Tennessee, and Missouri, could swell their production 1,500,000 bales.

In addition to the above, there are large areas suitable for cotton culture in southern California, Arizona, Nevada, Utah, Kansas, and Kentucky, So that, if the time should come when the spinners of the world require, say, 40,000,000 bales, the United States should be able to supply 25,000,000, or over 60 per cent of the whole, provided, always, that there was a sufficiency of labor and that other conditions were favorable.

We are therefore led to the conclusion that for many years to come the southern states will continue to hold the supremacy as the producers of the best and cheapest clothing material in the world.

THE MIGHTY RIVER OF WHEAT.

BY ROLLIN E. SMITH.

[Rollin E. Smith, agricultural editor; born Andover, Mass., April 27, 1853; graduated from University of Michigan, 1876, and studied at Bonn, Germany. He has written many articles for newspapers and magazines on chiefly agricultural topics. Author of The Nation's Crops. The following article is published by special arrangement with Munsey's magazine.]

The best wheat in the world is grown in the United States, and the finest is raised in Minnesota and North and South Dakota. The supremacy in quality is more important than the leadership in quantity. Furthermore, the business of raising wheat commercially—that is, raising it for the market rather than for the food of the local community—is developed in the northwestern states more perfectly than anywhere else in the world. Therefore, they play a most important part in feeding the world.

The patient persons who make statistics say that in 1903 the total wheat crop of the world was 3,193,556,000 bushels, of which the United States produced 637,822,000 bushels—a little less than one fifth—while Minnesota and the Dakotas contributed one eighteenth of the whole. Merely for comparison, it may be remarked that Russia ranks next to the United States as a wheat grower, raising nearly five hundred million bushels in Europe and Asia. France, the greatest bread eating country in Europe, comes next and British India is next.

Lest those who take a proper pride in the resources of this country should incline to boast unduly, it may be said that not wheat, but the humble potato, is the chief food stuff of mankind, and that Europe furnishes seven eighteenths of the supply. But the distinction of being the world's granary belongs to us, and we are likely to hold to it for all time.

Our resources as growers of wheat are not half developed. The average yield per acre in the United States, in 1899, was twelve bushels and three tenths. The year before, a banner year in wheat, the average yield was three bushels more. In

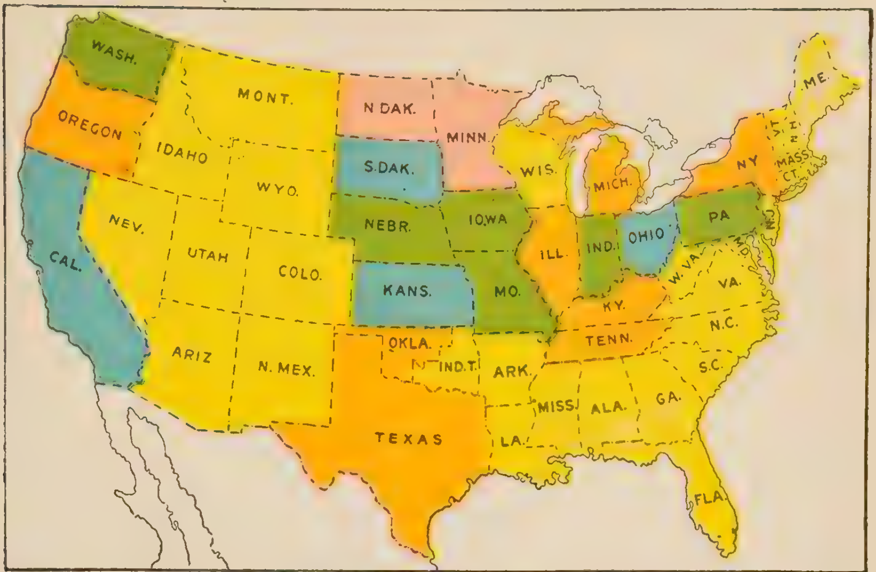
England, where land is much more costly and cultivation is more careful, an average as high as forty bushels to the acre has been obtained; but it doesn't pay to raise wheat in England, and it does pay in America.

Minnesota was probably the first state in which men made a business of raising wheat as distinguished from farming. Its agriculturists bought practically all their food and other supplies, and paid for them with the money obtained by selling wheat. They were really not farmers at all, but wheat raisers. The prairies stretching from the upper waters of the Mississippi to the foothills of the Rocky mountains are covered two or three feet deep with a rich black loam, marvelously fertile, and they produced that flint like kernel known as Scotch fife, or blue stem wheat, afterwards graded as No. 1 hard. This wheat, which makes the finest flour manufactured, no longer pours into Minneapolis. So little of the grain now reaches that grade that from being the standard it has almost ceased to be a commercial factor.

Twenty five years ago there were many miles of the best wheat land in the world open to settlers. All they had to do was to live upon it for a certain length of time to establish ownership. The flour mills of Minnesota were clamoring for wheat, prices were high, and fortune looked to be within easy grasp; so the homesteaders who flocked to Minnesota and the Dakotas were numbered by the thousands. Most of them were poor, and a good many of them froze or starved to death each winter. Few of them knew anything about farming. If they had, they would not have risked everything in wheat, for when that crop failed—as it sometimes did, because of drought, wet weather, or the ravages of the grasshopper—they were ruined. Still, enough wheat was raised for the market to pull down the high prices, thus adding to the misfortunes of the inexperienced settlers. So it came about that many gave up altogether, and hundreds and thousands of farms of one hundred and sixty acres each, the regulation homestead claim, were offered for sale for practically nothing.

This condition resulted in the bonanza farm, men with capital buying up the homestead claims. They overdid the thing at first by trying to conduct farms on an impossibly

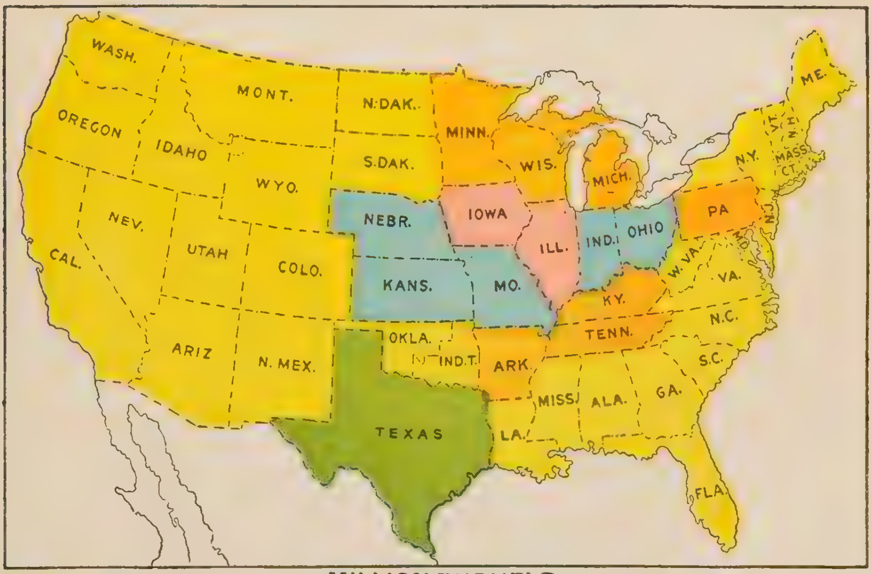
PRODUCTION OF WHEAT BY STATES



MILLION BUSHELS.

LESS THAN 10 | 10 TO 20 | 20 TO 35 | 35 TO 50 | OVER 50

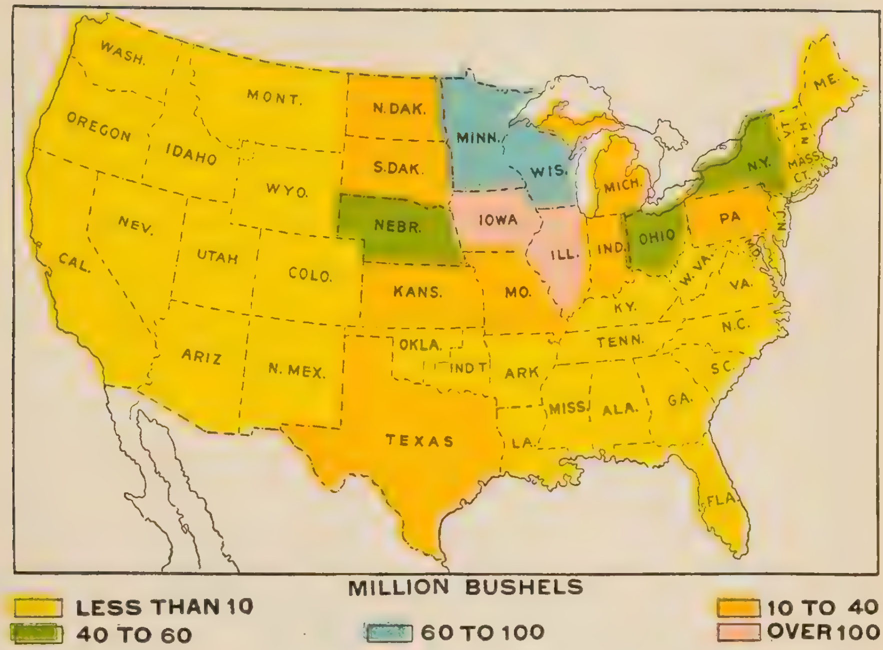
PRODUCTION OF CORN BY STATES.



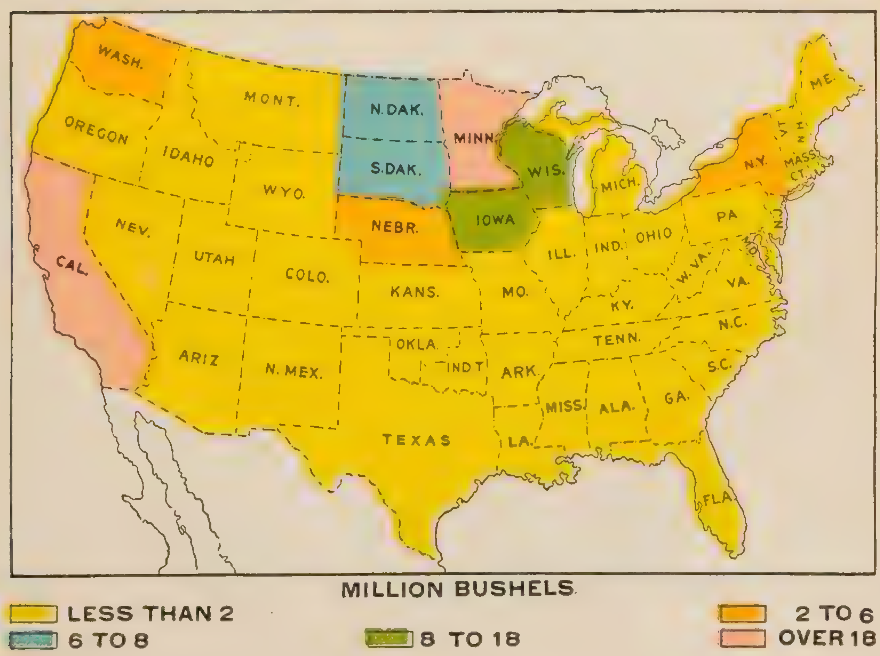
MILLION BUSHELS

LESS THAN 40 | 40 TO 100 | 100 TO 150 | 150 TO 240 | OVER 240

PRODUCTION OF OATS BY STATES



PRODUCTION OF BARLEY BY STATES



large scale. They had such distances to cover that their operations were inconvenient and costly. The largest of the bonanza farms was in North Dakota, and it originally included forty thousand acres—that is to say, sixty two and a half square miles—a tract eight miles long and nearly as wide. This farm has been reduced by selling parts of it from time to time, until now it measures but eleven thousand acres.

Wheat farms of from three thousand to four thousand acres are common, and are increasing in number. A tract of this size seems to be about as large as can be managed from one central point. Those of greater extent have been separated into divisions, each having its group of buildings, its gang of men, its horses and machinery. Such farms are possible only through the development of agricultural machinery, and more especially of the machines for harvesting grain. Plowing can be extended over a considerable period of time, and one man with a team can cover a good deal of territory during the season. A sower scattering the seed by hand could plant a large area; but when it comes to the harvest, conditions are different. When the grain is ripe, it must be cut at once, or the grain will begin to drop from the ears; and it must be stacked speedily to save it from risk of injury by the weather. Every moment's delay is serious.

From the time when the thin green blades of wheat appear above the ground till the harvest, the farmer has always been, and still is, practically helpless. He can do nothing to stay the ravages of locusts, droughts, excessive rains, or early frosts. He can only wait and hope. But the harvesting depends upon himself, and, nowadays, upon his machinery. If we should have to go back to the old scythe or cradle, or even to the earlier reaping machine, the big wheat farms would soon cease to exist. The wheat grower owes much to Cyrus H. McCormick—although if he had not invented the reaper and developed it, probably some one else would have done so. From McCormick's first machine, which he built in Virginia in 1831, the reaper has made a tremendous rise. The first advance was the placing of the man with a rake upon the machine itself. He quickly gave way to the automatic drag. Then the reaper was superseded by the harvester, on

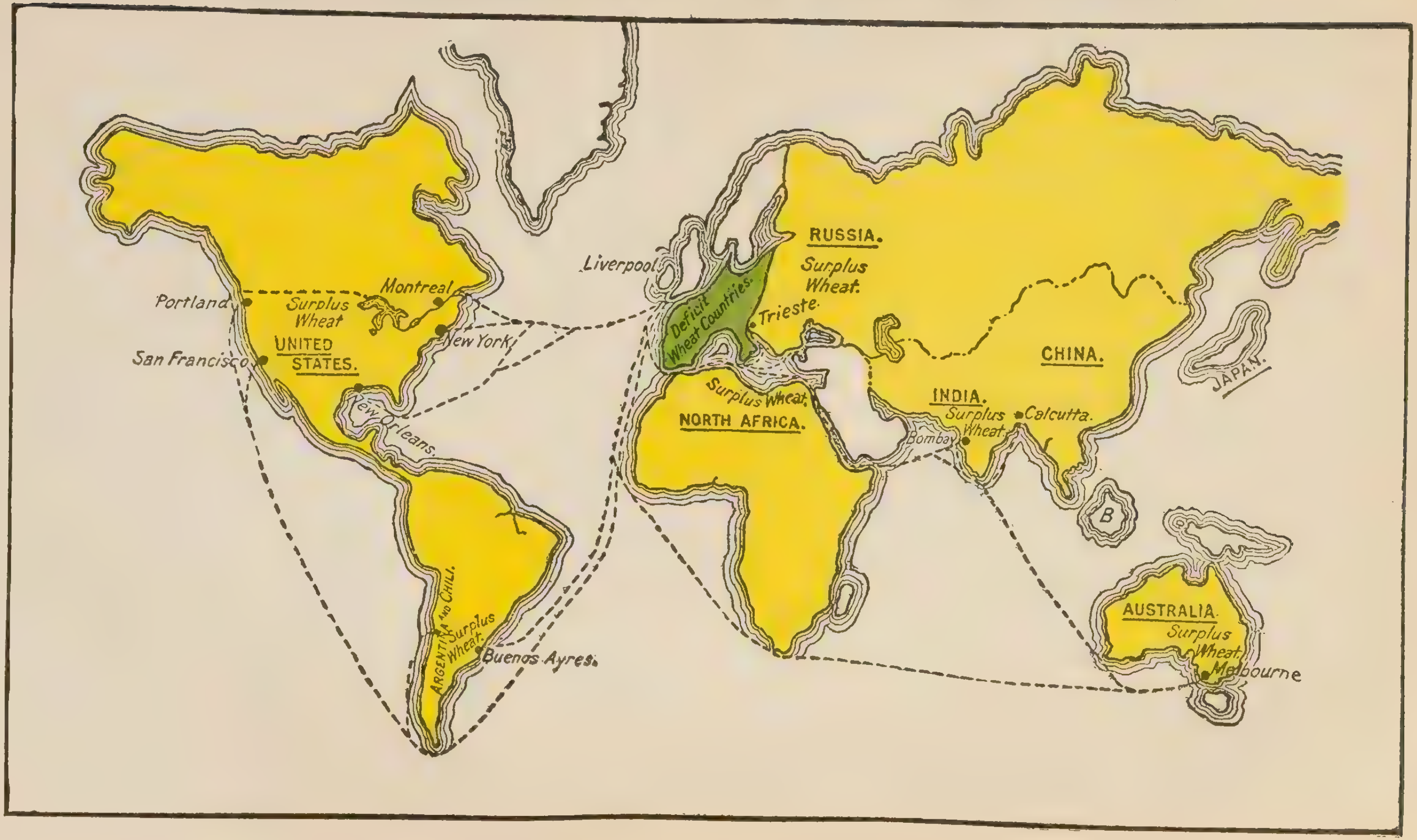
which men bound the wheat into bundles as fast as it would go. It became the ambition of every farmer's boy to bind his station once around the field without a halt. Next came the self binder, and this made farming on a large scale possible.

Other implements have kept pace, although no single one is so important as the harvester. On a farm of four thousand acres from twenty to forty men are employed, according to the season—except in harvesting and threshing time. In preparing the ground, fourteen or fifteen gang plows, each turning two furrows and drawn by four horses, are sufficient. On some farms steam plows are used, each turning a dozen or fifteen furrows; but steam has not yet superseded horses to any great extent. Seeding and harrowing require about the same number of men as plowing, one to each team of four horses. Some of these drags are forty feet wide, so that harrowing takes but comparatively little time.

The trying time on a wheat farm comes with the harvest. Often there is a lack of workers, but as a rule the supply is adequate. Somewhere down in the south, usually in Texas, or later in Oklahoma, there appears an army of unkempt, ragged men. Most of them are penniless, but they are ready to labor in the wheat fields from daylight to dark for double wages. They follow the harvest northward until the last bundle is shocked in Manitoba, and their numbers swell until, at the height of the season, there are forty or fifty thousand of them at work. The wheat stiff, as the migratory reaper is called, may work from May to September, or he may work only in July and August, but he earns enough to support himself, after a fashion, during the rest of the year.

A wheat grower who farms only a quarter section—a hundred and sixty acres—usually has a reasonably complete equipment of machinery, including gang plow, harrow, seeder, and harvester. On the big farms the machinery is simply multiplied. To cut four thousand acres of grain, from twelve to fifteen harvesters are required, each drawn by four horses. Besides the drivers, there are two men to every machine to shock the grain; and there are the expert machinest, who repairs the rather complicated harvester, the foreman, and

MAPS OF THE WORLD'S SURPLUS AND DEFICIT WHEAT COUNTRIES.



the workers about the stables and houses—some fifty or sixty men all told.

The thrashing of grain is not nearly so pressing a task. The big bonanza farms, of course, have their own thrashing outfits, which separate not only their own grain, but often that of their neighbors. Then there are peregrinating outfits that go from one farm to another, often traveling many hundreds of miles in the course of the season.

Much more complicated than the growing of the grain is the marketing of it. Time was when the farmer in the northwest was absolutely at the mercy of the commission merchants and the railroads—particularly the railroads, who taxed him remorselessly until the discovery was made that the tillers of the soil could control politics and make laws themselves. Since they have made the railroads dance to their piping.

The marketing of wheat has become a science, coupled with about as many uncertainties as it is possible to imagine. The mechanical devices are well nigh perfect, but the speculative opportunities are so great that while the expression "as good as wheat" still maintains in the northwest, the risks of the game can scarcely be exaggerated. The bonanza farmers, being men of wealth, and conducting their enterprises on scientific and careful business principles, have done a vast deal of good to the smaller farmer, who has learned to watch the market, to study conditions at home and abroad. The wheat grower of to-day knows when it is wise to sell his wheat and when to keep it—this, of course, being upon the supposition that he is not pinched by necessity.

Of course wheat, to be valuable, must be taken to the market; and those whose business it is to handle it have discovered that it is well to establish the market as near to the farm as possible. This has resulted in the development of a system of elevators—a system that is one of the most perfect ever devised by commercial men, and that has no parallel in any other country. In almost every town in Minnesota and the Dakotas there is an elevator connected with Minneapolis and Duluth, the two greatest primary wheat receiving points, from whence it is distributed to mills or shipped on

eastward, by way of the great lakes in summer, and by train in winter.

In Minneapolis there are from forty to fifty elevator companies, operating about two thousand country houses, which have a combined storage capacity for about fifty million bushels of grain. In addition, there are in Minneapolis about thirty terminal elevators, with a combined capacity of thirty million bushels. The largest individual terminal elevator will hold two million three hundred thousand bushels. The country houses can store from eight thousand to ninety thousand bushels of wheat apiece. While the elevator companies are entirely independent of one another, together they form a great system. They work as harmoniously as possible, but competition often rages fiercely.

The wheat industry has built up the railroads in these great wheat producing states, and has brought into existence many towns, so that it seldom happens that a farmer need haul his grain more than a dozen miles in order to find a purchaser. Usually he can find two or three purchasers, because the elevator companies have local managers in each town, and there are also independent buyers, to say nothing of the representatives of flour mills. Changes in the price of wheat are sent out from the offices at Minneapolis every night, and at times of decided fluctuation the buyers are usually notified by telegraph. On the other hand, the country buyers advise their principals at night by mail of the amount of wheat they have purchased during the day, or, if an unusually large amount is bought by noon, the company is informed of it by wire.

When the new crop moves, the wheels of commerce begin to hum through the whole northwest, and trade and railway traffic are affected all the way to the eastern seaboard. Money from the banks flows to the wheat country, which is flooded with clean new bank bills fresh from the Treasury. The elevator companies borrow large sums of money; and as fast as the grain comes in, money goes back by express, for, in the first instance, wheat is always sold for cash. With money in their pockets, the farmers are good customers in the small towns. The retail dealers increase their orders with the

jobbers, who in turn make glad the hearts of manufacturers, while the transportation companies profit all along the line. In Minnesota and North and South Dakota alone, a good crop amounts to about two hundred million bushels, so that a rise or fall of twenty five cents a bushel means fifty million dollars in cash, more or less, as the case may be, to the farmers, and therefore, to the merchants, jobbers, and manufacturers.

The new wheat comes pouring into Minneapolis from the surrounding country in numberless and almost endless streams. The daily receipts mount up to eight hundred and a thousand cars a day. Each car holds about eight hundred bushels. This wheat must be inspected by state officials within twenty four hours. After the inspection, a sample from each car is taken to the floor of the chamber of commerce. The buyers representing millers, who usually want to grind the wheat at once, go about from table to table, making their selections. After the grain has been sold, it must be weighed by a state official, and then it is switched around to mill or elevator, where it is unloaded in fifteen minutes.

Wheat that goes into the big terminal elevators parts company with that which goes to the mills. The latter quickly loses its identity, becoming manufactured product, while the former is classed as raw material. Its commercial importance is greatest, probably, when it is lying in the elevators in bulk. Although idle itself, it has a powerful influence upon financial conditions, for it represents actual cash that is circulating in traffic, in the same sense that gold deposited in the United States treasury is represented by gold certificates.

No part of this wheat is held for speculation; it has all been sold for future delivery, and may be bought back and sold again, remaining in the elevators for many months, sometimes for a year. But it is not money tied up. It is so much collateral, and the bankers are greatly interested in it because of the large sums of money they loan to elevator companies. Warehouse receipts are issued at request on wheat in public elevators, and the banks are always ready to lend money on them. It is plain, therefore, that with a visible supply of, say, fifty million bushels of wheat in the

country, on a large part of which the banks are loaning money, they are as anxious for high prices as the farmer himself.

The farmers sell their wheat according to their necessities or their judgment. Nearly all of them dispose of a considerable part of it immediately after it is thrashed, to pay harvest expenses and to meet other demands. Many of the smaller farmers are compelled to sell their whole crop. The carrying of wheat is a most uncertain proposition, and while it may turn out profitable, it is just as likely to result in heavy loss. But the holder of wheat, be he farmer or elevator man, is sure of always being able to sell for cash at the market price.

By far the most interesting sides, as well as the most complicated ones, of the wheat industry are the elevator systems and the speculation in wheat. The elevator business and speculation have nothing in common, but they are so correlated that it is difficult to keep them separate. Although it may seem paradoxical, it is true that the elevator companies take advantage of the speculative markets to avoid risk; or, to put it in another way, they are constantly buying and selling futures to escape speculation.

The business of the elevators is the storing of grain. The companies are really warehousemen. Their profits come from full elevators. They carry a vast quantity of wheat for other people, but in order to insure these big storehouses being kept full, they often find that they must buy the grain themselves. When they buy a large amount of cash wheat, and place it in their buildings, they sell a similar amount on 'change in Minneapolis or Chicago. In other words, they contract to deliver that wheat at some fixed time in the future, at a price that is at least equal to the price of cash wheat plus interest, storage, and other expenses, known as carrying charges. A million bushel elevator may be full of wheat that cost, say, seventy cents a bushel. The market price may advance to a dollar, or it may drop to fifty cents, and the elevator company neither jubilates nor mourns, because the fluctuations affect it not at all. The wheat is "hedged"—that is, it is sold for delivery at some future month, and a fair profit is assured to the company.

Perhaps the actual wheat is delivered at the specified time, although that is not so common. It may be sold for cash to another buyer—a mill, for instance, that needs wheat and is willing to pay an advance. In that case the elevator company buys in the amount of wheat it sold for future delivery. This is called taking in its hedge. Perhaps the transaction in futures shows a profit. Perhaps the elevator company sold the May wheat, let us say, for seventy five cents, and had to pay seventy six when it bought it in. The sale of the actual wheat must show a profit to cover this loss.

It doesn't make the slightest difference who buys the wheat on 'change. It may be a scalper, another elevator man taking in his hedge, or a broker for a speculator pure and simple—for the transaction is adjusted in the clearing house. While the elevator company is taking no risk, some one must do so. It is the intermingling of speculation, gambling, and legitimate business that makes the wheat business the most complicated in the world, and learned judges have found it impossible to distinguish an exchange where wheat is bought and sold from a bucket shop, which is a gambling shop pure and simple, and also a den of thieves as well.

In the east men of a speculative turn of mind dabble in stocks, and as a rule they have a deadly fear of the grain market. In the west wheat is the foremost speculative commodity. It is much more uncertain than stocks, and not so easily manipulated by a group of men. The information that is gathered for the big wheat and flour men comes from the ends of the earth. Their intelligence departments cost millions every year. They know how the harvest is going in Australia and Chili in January, and they watch strained diplomatic relations. They know about a threatening storm in the northwest that may affect the growing crop, and a change in freight charges to Hong Kong or to Constantinople. They measure the available wheat in the world, which they call the visible supply, and estimate its quality. Where there is one influence that may affect the value of stocks, there are ten to make wheat prices fluctuate.

It is of course perfectly well understood that comparatively little of the wheat bought and sold in the wheat pits

has any existence. In one day during a wild flurry in the market, some twenty five million bushels of wheat changed hands in the Minneapolis chamber of commerce. Of this amount it is safe to say that not more than a million bushels represented actual wheat in elevators, or anywhere on earth. At the close of the day, if the brokers' books could have been balanced all together, the amount of speculative wheat they held would probably have been only about the same amount. It was a mere buying and selling back and forth—much like a dozen men paying a dozen half dollar bets with the same coin.

As much wheat was sold that day as was purchased, of course, yet the price advanced, for the buyers were more eager than the sellers. It is not the actual amount of wheat bought or sold that advances or puts down the price, but the temper of the buyers or the sellers.

The question of price naturally leads one familiar with wheat to think of corners. The term is understood in the trade to mean the purchase, by one man or combination of men, of more grain than is in the regular warehouses on the last delivery day of the month. This artificially inflates prices, for, as the actual wheat cannot be purchased by the men who sold "short," so that it can be delivered on the contract, the one who has cornered the market can make them come up and settle at his own terms. This is the theory; it has seldom actually been done. Very few real corners are recorded, although a number of deals, more or less profitable to their engineers, have been called corners.

No better illustration can be given of the influence wheat has on the commerce of the world, and of the fact that the price is influenced by the tone of the buying or selling, whether aggressive or half hearted, than the Leiter deal, in 1897–98. It was not a corner. It was the buying of future and cash wheat on a scale never before attempted, and an endeavor to get the actual wheat out of sight by exporting it to consuming markets. Although he had to meet the heaviest kind of opposition, and exceedingly persistent short selling, Leiter's steady buying finally appalled the bears and changed the tone of the market. The speculators, who had been afraid of wheat at a dollar a bushel, stampeded like a flock of sheep,

and were eager buyers at a dollar and a quarter. The frightened shorts took the market out of the young speculator's hands. In their scramble for wheat he lost control of it, and in May, 1898, the price went to \$1.85 in Chicago. Could he have controlled the market and kept it from this wild advance, he would have made millions; but the extreme high price was the means of his downfall. The influence of the price was felt as far away as the interior of Russia, and by the scraping of bins all over the world a volume of wheat, some twenty millions of bushels, that no one had dreamed of, was poured into the market. A crash followed that carried wheat down to sixty six cents within sixty days.

But while the speculators try to get rich and ruin one another in buying and selling imaginary wheat, the purely legitimate business goes on. Millions of bushels are sent to Duluth, where they are loaded by machinery into great barges that were once schooners, and huge steam vessels, which have taken the place of the whaleback because those queerly shaped craft are not economical. In foul weather, as in fair, the sailors of the unsalted seas plunge on, steering by compass and chronometer in the worst of storms. There is a rest at the Sault Ste. Marie canal, whose commerce in the eight months of navigation is nearly three times greater than that of Suez in a whole year, and then on to Buffalo, where a cargo of a hundred and fifty or two hundred thousand bushels can be unloaded in a few hours into the huge steel elevators, which in turn can fill a freight car or a canal boat in a few minutes, and all for a penny a bushel. At the seaboard the grain is loaded into ships and sent across the sea to feed millions in England and France and Germany who depend upon us for their bread.

INDIAN CORN.

BY CHARLES F. MILLSPAUGH.

[Charles Frederic Millspaugh, physician, curator department of botany, Field Columbian museum, Chicago, since 1894; born, Ithaca, N. Y., June 20, 1854; educated at Cornell and New York Homeopathic medical college; practiced medicine in Binghamton and Waverly, N. Y.; botanist, West Virginia university, 1891–3; professor medical botany, Chicago Homeopathic medical college, since 1897; professorial lecturer, economic botany, University of Chicago, since 1895; explored in the interest of botanical science in Mexico, West Indies and Brazil; editor, Homeopathic Recorder, 1890–2. Author: American Medical Plants, Weeds of West Virginia, Flora of St. Croix, D. W. I., Plantae Yucatanae; contributor to various scientific and popular journals. The following article was published originally in the Chautauquan.]

No product of the soil bore a more important relation to the welfare of the early American colonists, or provoked a deeper interest in the new world and its agricultural possibilities, than maize or Indian corn. Next to gold itself the golden grain excited the cupidity of the early explorers and settlers, and its confiscation and destruction by them tended to embitter the aborigines against the paleface who was showing a constantly increasing tendency to invade their domains along the eastern coast. Some account, therefore, of the origin and spread of this cereal which, next to rice, now feeds more of the world's people than any other grain, will prove of interest in this particularly active period in the study of American history and economics.

While there is no doubt that Indian corn originated in America, and at the discovery of the country had been so long in cultivation that its many forms had reached nearly the perfection that they have to-day, there is the same difficulty in positively naming its natural progenitor as in the case of every other prehistoric vegetable now cultivated for food by man.

That corn was originally a grass belonging to the genus known as Zea, is evident to the botanist; but whether this grass grew in Paraguay, and bore ears upon which each kernel was enveloped in a separate glume or pod, just as we find them in reverted ears in the field to-day; or whether it grew on the upper plateau of Mexico, and put forth bunches of little ears having but two rows of kernels on each, as lately dis-

covered by Professor Duges, is a question which will probably never be definitely settled. It is certain, however, that from whichever of these forms the product sprang, the first successful step in producing this food resulted in a pop corn, and from this, through husbandry practices and varying environment, the sorts now known have been brought about.

The presence, not only in the graves of the ancient Peruvians prior to the dynasty of the Incas, but in geological formations of unknown antiquity, of many varieties of well developed corn, the result of centuries of cultivation, certainly points to a peopling of the western coast of America at a far earlier date than has generally been supposed.

The ears of corn found enclosed in the wrappings of Peruvian mummies are usually short and of a deep mahogany color. Upon them the kernels are well developed, and arranged in ten rows. Ears found farther north, in the caves of the cliff dwellers, are principally composed of light yellow kernels arranged in twelve rows. In the graves of the mound builders of North America corn is always found; but, being carbonized in every instance, its character cannot be positively determined. Among the Indians of northeastern North America it was usually yellow or white, and had fourteen rows of kernels; these ears are not to be distinguished from those of similar varieties grown in the same localities by the farmers of to-day.

Having doubtless, then, originated in its natural home, the table lands of the western Andes of Peru or those of the Sierras of Mexico, this principal vegetable food of many primitive peoples gradually worked its way, through barter and strife, along the Pacific mountains both north and south. From its northern extension it proceeded eastward through our great western prairies; and from its southern, again eastward along the northern confines of South America, and through the Antilles to the peninsula of Florida, where, as it proceeded northward, it joined in our eastern states its migration from the west.

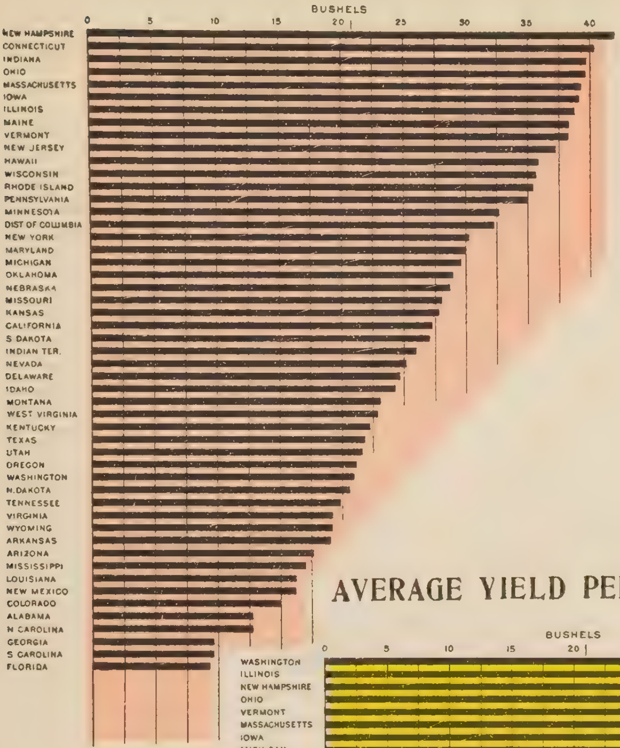
So extensive had the cultivation of this cereal become at the time of the discovery of America, that it was nearly the first object that attracted the attention of those who landed

upon our shores. Thorwald, brother of Lief, saw wooden cribs for corn upon the Mingan islands A.D. 1002; and Karlsefn, in 1006, and Thorfin each saw and brought aboard their ships ears of corn from the shores of what is now Massachusetts. Columbus found maize in Hayti on his first voyage in 1492; and in 1498 reported his brother as having passed through eighteen miles of cornfield on the isthmus. Magellan supplied his ships with maize at Rio Janeiro in 1520; and every explorer mentions the grain from Columbus's time to that of the arrival of the French at the site of Montreal in 1535 in the midst of extensive corn fields. Cabeca de Vaca in 1528, and De Soto in 1539 landed in Florida, and both speak of the fields of maize, beans and pumpkins that they found there in great abundance. In 1605 Champlain found fields of corn at the mouth of the Kennebec; and Hudson in 1609 saw a great quantity of maize along the river that now bears his name.

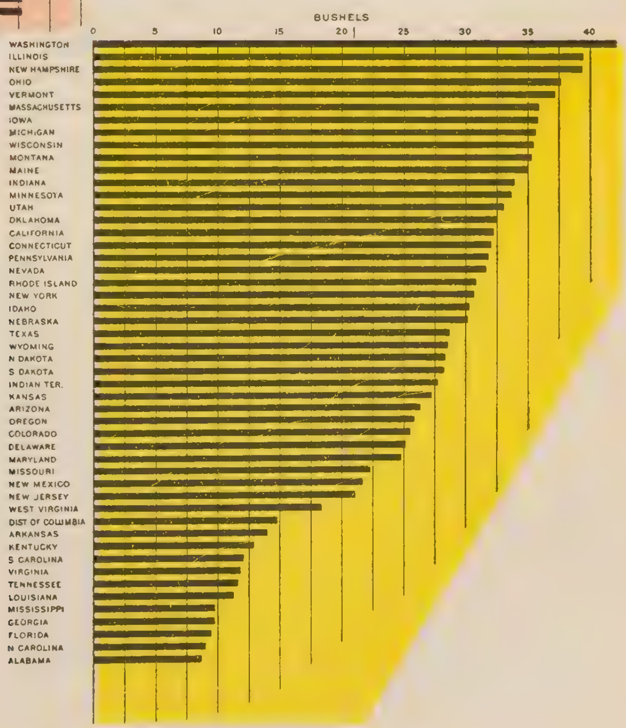
Captain Miles Standish tells us that when the Puritans landed upon the coast of New England in 1620 they found about five hundred acres of ground that showed signs of a former crop of corn, and that later they discovered a cache of the grain. It was maize that carried them safely through the long and dreary winter, and when spring came they began to plant the new cereal themselves: "We set the last spring some twenty acres of Indian corne, and sowed some six acres of barley and pease. . . . Our corne did prove well, and, God be praised, we had a good increase."

The aborigines were everywhere found sufficiently versed in agriculture to know the value of fertilizers applied to their fields. The Mayas of Mexico used for this purpose ashes formed by burning the rubbish accumulated in clearing the land; the Peruvians used bird guano gathered from the islets off their coast, and even went so far as to protect the birds and ensure the supply by putting to death any one who disturbed them during the nesting season, or killed them at any time; and the North American Indian, when his fields were near enough to a supply, used fish as a fertilizer. The Plymouth colonists were taught by the Indians "both ye manner how to set ye corne, and after how to dress & tend it; and

AVERAGE YIELD PER ACRE OF CORN



AVERAGE YIELD PER ACRE OF OATS



were also tould axcept they got fish & set with ye corne, in old grounds, it would come to nothing."

In poor return for this great gift, one of the most heartless methods of warfare against these rightful owners of the soil was the devastation of their cornfields by the Connecticut colonists during the Pequot war in 1637,—a method copied from the Indians themselves as practiced in their tribal wars. The Puritans followed up this method in King Philip's war in 1675; and Marquis de Nouville, in his celebrated expedition against the Senecas, "spent ten days in destroying the corn, which including the old corn that was in cache, which we burned, was in such great abundance that the loss was computed at 1,200,000 bushels." The French army under Frontenac, in 1676, spent three days destroying the corn of the Onondagas. The cruelty of this method of warfare was so evident to good Father Hennepin, who accompanied La Salle in his expedition down the Illinois river in 1679, that he says, "We durst not meddle with the corn that we found in a village, for it would be the most sensible wrong one can do them, in their opinion, to take some of their corn in their absence."

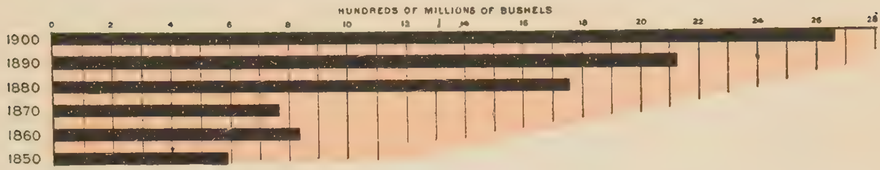
From the accounts of early explorers and historians we learn that the aboriginal methods of preparing corn for food were many and varied, though all were practiced substantially alike by the peoples of South, Central, and North America. The fresh ears were roasted or boiled, or the kernels stripped from the cob and cooked with beans. This they called msickquatash, from which came our name succotash, applied to the same dish. At times bits of pumpkin, nuts, berries, or the shredded meat of game were cooked with the corn, thus adding the proteid material necessary to form a satisfying and sufficiently nourishing food.

In the absence of mechanical mills of any kind for grinding the old ripe corn, which, being stable and portable, was necessarily the most usual food form, the following method of reducing the grain to edible condition was practiced throughout the country, and still maintains among the natives of Mexico and South America: Sufficient shelled corn for the food of the family the following day is put to soak at nightfall in boiling hot water, to which a little lime is added for the

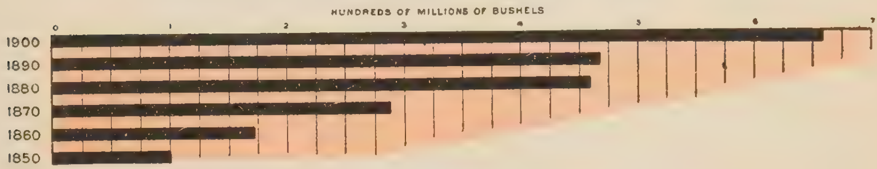
purpose of removing the hull. By morning the grain is soft and ready for grinding, or rather mashing to a pulp. One of the younger females of the household dips from the lime-water a few handfuls of the corn at a time, which she places before her on the upper end of an inclined flat stone; then grasping by the ends another stone, somewhat like a rolling pin in shape, she works the kernels down between the two with a peculiar motion allied to that employed by a boatman in feathering his oar, during which she throws all her shoulder strength and body weight into each stroke. The pulp, thus deftly crushed, collects at the lower end of the nether stone, whence it is taken by one of the older women and kneaded into a dough without the addition of any condiment or even salt. Taking this dough she sets herself before a low flat stone or bench, upon which she lays a banana leaf. On its smooth surface she forms thin, circular, even wafers, and toasts them one at a time, as made, over a slow fire, upon a flat stone or pottery slab, or in these days,—in families of sufficient means—on the iron griddle of civilization. The resulting cakes, or tortillas, are eaten while hot, either alone or with boiled beans, meat stews, or other pottage, by using them as spoons, and biting off a portion of the spoon with each mouthful. Such of the tortillas as are not needed at the meal are afterward eaten cold, or retoasted in the ashes. Among the Pueblo Indians, dough of blue corn produced in the same manner is rendered thin with water and spread with the fingers upon a large, flat, heated stone in a thin sheet which, when baked, is rolled into a cylinder and eaten as required.

Sweet corn was also cultivated by all tribes living upon fertile and well watered plains, and was greatly esteemed. Though a number of travelers spoke of a certain kind of corn with shriveled grains, as being found among the Indians, the first specific mention of this form in American literature occurs in The New England Farmer of September 7, 1822, where the writer of an anonymous article relates that: "Lieutenant Richard Bagnoll, returning from General Sullivan's expedition against the Six Nations in 1799, brought some corn called papoon corn, which was the first sweet corn ever seen in New England."

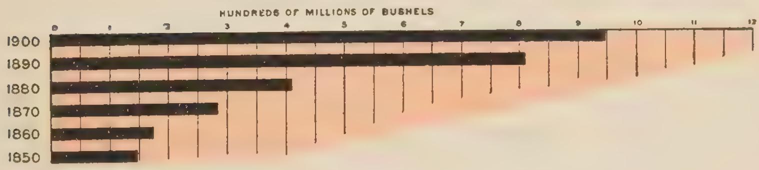
PRODUCTION OF CORN, 1850 TO 1900



PRODUCTION OF WHEAT, 1850 TO 1900



PRODUCTION OF OATS, 1850 TO 1900



PRODUCTION OF COTTON, 1850 TO 1900

Corn is so essential to the life and welfare of the resident tribes of southwestern North America that it forms the basis of their religion, the burden of their mystic song, and the object of their prayer.

The most important so-called religious ceremonies of these tribes are in reality invocations to the clouds, the winds, the rains and the sun, propitiating all these forces of nature, to the end that the corn may grow fruitful and the crop be large. On their ceremonial altars corn is always an important factor, and around it the symbolism of all dependent nature is grouped. In the Blue Flute Altar of the Hopis, the background represents the god of thunder, above whose head rise banks of summer clouds, among which vivid streaks of lightning play and thence run down his legs, along his sides and at his feet. Winged to his hips are other cloud forms from which straight bars of falling rain depend. Before him on the ground stands the sacred vessel, and with it the reverenced tiponi—an ear of corn enwrapped with cotton twine and surmounted by feathers, the palladium of the chief priest. Flanking these on either side are symbolical birds and blossoms, flowers and fruits, the product of a beneficent summer. In the foreground is "the six directions altar," distinctive of all ceremonies among these people. This sub-altar consists of a medicine bowl, aspergill, and six ears of different colored corn. The bowl contains the charm liquid with which the spectators of the ceremony are asperged, an act representing the blessing of rain. The ears of corn symbolize the cardinal points and two in addition: a yellow ear for the north, a blue for the west and evening, a red ear for the south, a white one for the east and the rising sun; a black ear for the clouded heavens above, and an ear of sweet corn for the water beneath the earth, from which the sun draws the supply for the clouds.

With this knowledge the dances and rites of these people no longer appear heathen and idolatrous, but rather poetic and symbolical.

Corn has now become the greatest crop raised by the American people. Not only does it employ more acres than any other grain, but nearly as many as wheat, oats, rye, bar-

ley, buckwheat, and cotton combined. In its culture, harvesting and feeding it provides more employment for farm labor than all other agricultural staples, nor does its value in affording occupation to labor cease, like wheat and cotton, after the harvest is done. The yield of America's principal grain for 1904 was about 2,224,177,000 bushels, shelled—a product the transportation of which taxed to the utmost our extensive railroad systems, and the fleets of the great lakes.

The uses of the residue of this large product, after the exported amount is deducted, are indeed various. Besides the consumption of the grain by man,—as hominy, samp and meal,—a large amount is converted into meat through the media of domestic animals and fowls, and into force through horses and mules. Another large portion is converted into starch, both for food and for domestic purposes; in fact, most of the starch manufactured in the United States is yielded by corn. From the refuse of the starch factory a sort of sugar, called glucose, is obtained, which is utilized by the confectioner. Oil, giving a fine white light and a high degree of heat, and excellent as a lubricant for machinery, is expressed from the malted grain, which also yields nearly all the spirits produced in this country, and a part of the beer. Paper tougher than that made of rags, a coarse fiber useful for cordage and bags, and a finer for cloth, are made from the leaves and stalks. The husks are used for packing purposes, for the stuffing of mattresses and couches, and as wrappers for cigarettes. In the western states, where the supply of fuel is uncertain, the whole ear is often used for fuel; three tons of the cobs alone being equal in heat value to a ton of hard coal. The cobs are utilized for bottle stoppers, in substitution for cork, and incidental to their use as fuel they yield seven pounds of potash to the thousand; they are also extensively utilized for the manufacture of pipes. The pith of the stalk has been proved to be an excellent packing for armored naval vessels. The stover that remains after the ears have been harvested is claimed to be equal to the best hay in nutritive value, and fresh or siloed corn is one of the best of fodders for milch cows.

Besides these major products, many minor substances are obtained, such as coffee prepared from the coarsely ground toasted meal; a diuretic medicine from the silk, and a sort of ergot from the smutted ears; palatable bread is made from the tissue between the leaf ribs, and a useful paste from the residue of the paper making processes; while the freshly cut stalks and butts yield a crystalline cane sugar, though not in sufficient quantity to be profitable, so long as sugar cane and sorghum are available.

A plant subserving so many important purposes cannot fail to occupy a still more prominent position in the future agricultural interests of our country, and to become better known to the people of other nations. Its wider use is being brought about through its own merits, the efforts of the society for the promulgation of maize foods, and the special illustrative exhibit made by our government at the Paris exposition; all of which will prove a great factor in increasing the wealth of the American farmer.

STARCH.

BY H. W. WILEY.

[Henry Washington Wiley, chief bureau of chemistry, United States department of agriculture; born, Kent, Ind., October 18, 1847; graduated from Hanover college, 1867; Harvard, 1873; professor of chemistry, Purdue university, 1874–83; state chemist of Indiana, 1881–3; professor of agricultural chemistry in graduate school of Columbian university since 1895; member Jury of Awards, Paris exposition, 1900; delegate to Fourth International congress of Applied chemistry, Paris, 1900, and fifth congress in Berlin, 1903. Author: Principles and Practice of Agricultural Chemistry, 3 volumes; and contributor to the National Geographic magazine and other scientific papers.]

Starch is one of the principal components of all cereal grains, and of certain root crops, such as the potato, the sweet potato, the cassava, and others. The most important uses of starch are, first, in the laundry; second, for the manufacture of glucose; third, for edible purposes; and fourth, for use in the textile industries. The principal commercial sources of starch are the cereals and potatoes. In the United States Indian corn is the principal cereal employed in making starch for commercial purposes. The only other cereal which is used to any extent is wheat, and the use of this cereal is extremely limited. A large number of establishments in the United States also produce starch from potatoes, but in a very small way. Practically five sixths of the commercial starch of the United States is derived from Indian corn. In Europe the principal source of starch is the potato, and this tuber is used very extensively on the continent and in England for this purpose. In tropical countries considerable quantities of starch are made from the different varieties of the cassava, and this industry has lately been introduced into the United States, since cassava grows well in Florida and some other southern parts of the United States. The starch made from the varieties of the cassava is used either as indicated above or for the manufacture of the food product known as tapioca.

The methods of manufacturing starch used either for pure starch, on the one hand, or the manufacture of glucose

on the other, is as follows: Grades of Indian corn numbers 2, 3, and 4, and grains of no grades are used, but chiefly number 2. The corn is bought shelled in the open market. Cobs and leaves are removed by means of an inclined mechanically shaken sieve through which the grain passes; dirt and fine dust are removed by fans; and nails and other iron scraps are removed by magnets. Large tanks made of wood, iron, or copper, with a capacity of about 1,000 bushels, are used for steeping or softening the corn. Water charged with three fourths of 1 per cent of sulphurous acid and heated to 125° F. is used for the softening of the grain; the water is circulated from the bottom to the top by means of a steam injector, and from twenty four to thirty six hours are required to complete the steeping. The soft, warm grains are ground or cracked with ordinary $4\frac{1}{2}$-foot French burr mills; the grinding being only carried far enough to loosen the germ, and not break it. The cracked mass is thrashed three times in order to complete the loosening of the germ. The thrasher is a box containing two circular shafts, fitted with blunt steel arms, making from 1,500 to 2,000 revolutions per minute. The thrashed mass is passed between rubber faced rolls, and the excess of starch liquor is removed from the germ, etc. The wringer is an ordinary five roller laundry wringer carrying an endless steel gauge belt between the rolls. Technically they are known as slop machines.

The semi-dried mass is fed into the germ separators, where, in consequence of the difference in specific gravity between the germ and shells, the germ floats and the shells sink in a starch solution of 8.5° Baumé. The germ and some starch liquor overflow at one end and at the top of the separator, and the shells and a little more starch liquor are removed from the bottom by a motor pump. To facilitate the removal of the germ, paddles or sweeps drag the germs to the point of overflow and a screw conveyor form of agitator in the bottom of the separator does the same for the shells. The separator is much like a masse-cuite mixer. It is filled and kept filled with 8.5° Baumé starch liquor.

From the separators the germ and the starch liquor are fed upon a great many copper sieves or shakers, where the

starch liquor is removed from the germs and the germ is freed from adhering starch by washing with water. The shakers are set at a slight angle and are given about 400 lateral throws of 1½ inches per minute. The shaker bottom is covered with a perforated sheet of copper. The washing water comes from small V-shaped troughs running crosswise of the shakers and having their sides perforated.

The germ is put into large sacks or cloths of coarse mesh and subjected to a pressure from a hydraulic press. From this press the germ enters a revolving steam heated dryer, much like a sugar granulator, and all but 3 per cent of the moisture is removed. A suction fan removes any dust or light particles. The dried germ is run into aspirators, where the shell and points of the germ are removed by fans and screens, and after cooling it is fed to a five roller shell mill, where it is ground to a fine meal. The mills are of the regular linseed mill pattern, with one roll set over the other. After grinding, the germ or meal is fed into a double bottom steam heater or cooker, and from this into another, and at the same time a small jet of steam plays on it as it is moved about by the agitators, in order to supply the required moisture. The meal is heated until it is just bearable to the hand.

The heated meal is fed from the bottom of the cooker into a form; this form in turn drops the meal on a cotton cloth, and the attendant folds over the ends of the cloth, and by means of a piston driven by steam, forms and compresses the cake. The formed cake is slipped between the plates of a regular oil press holding 16 cakes. A hydraulic pressure of 4,000 pounds to the square inch removes 90 per cent of the oil. The oil is filter pressed through cloth or paper and allowed to settle in large iron tanks for several days. After this it is barreled and is sold in this form of package. The oil cake containing 10 per cent of oil is sold as a cattle food, principally in Europe.

The shells and other unground parts that are removed from the bottom of the germ separator are called the first grind. From the separators this is fed upon rapidly oscillating silk sieves or shakers. Here the mass is drained, the starch liquor passing through the silk and going to the starch

supply tank. The drained first grind is fed into a second net of burr mills, when the starch adhering to the shells is removed as far as practicable.

The feed or second grind is fed upon silk sieves or shakers. The first half of the shake simply drains the starch from the second grind without any washing. These drainings are also sent to the starch supply tank and are washed five times in passing over the second or last half of the shakers in order to remove all adhering starch. The feed passes through a set of wringers for the final removal of any free starch. It is then mixed with the solids from the steep water, and the gluten is pumped into large presses, where 45 per cent of the adhering moisture is removed. These presses are very large, carrying 100 plates, and are operated by hydraulic pressure.

The feed after being broken by thrashers is carried into large steam dryers, where the moisture is reduced to 20 per cent. After again passing through thrashers it is conveyed into the finishing dryers, where all but about 10 per cent of moisture is removed. It is then ground to a fine meal by food attrition mills, which have two flat disks revolving in opposite directions at a speed of 2,000 revolutions per minute. The disks have little square pockets, one fourth by 1 inch and one fourth inch deep, giving an enormous cutting surface. The feed is sold as gluten, buffalo maize, and golden feed, and is one of the well known concentrated cattle feeds in the market.

The washings of the second grind on the second shakers that are very dilute are run into cone settlers, where the excess of water is removed and the concentrated starch liquor is sent to the starch supply tank. These cone settlers are circular iron tanks, with cone bottoms, and are about 12 feet deep. The starch enters a 10 inch pipe, extending from the top to within 36 inches of the bottom. The point of the cone has a one half inch outlet for removing the starch. The water overflows at the top of the tank. By this arrangement the settling and drawing off of the water and starch are continuous. The accumulated starch liquors are collected in the supply tank from all parts of the house, after being run upon

a set of silk shakers carrying a very fine mesh silk, known as No. 20. These shakers remove the finer particles of feed, etc.

From the shakers the starch is fed in small streams to the starch tables, where the starch settles and the gluten runs off at the end of the table. The tables are long gutters, 20 inches wide, 9 inches deep, and 100 feet long, with a fall of about 4 inches in that length. When the tables are filled sufficiently the starch is scraped with rubber edged scrapers and is shoveled upon carriers. These carriers empty into large 12 foot tubs or breakers, where the starch is mixed with enough water to make a solution weighing either 24° Baumé, or 6° Baumé. The 6° starch is again passed over No. 20 shakers and is then run on another set of tables to remove any adhering gluten or other impurities carried off by the water. After scraping, or rubbing and draining, the starch is removed from the tables by carriers.

From the carriers the starch is fed into breakers or thrashers, and, after being broken into pieces the size of a hen's egg, it is loaded into shallow canvas bottom trays. These trays are put on a wagon and the wagon run into kilns. These wagons are run on tracks, and are fitted with racks to hold 14 trays equaling 1 bag of starch, or 300 pounds. The starch remains in the kiln twelve hours, and is gradually moved from the air outlet end of the kiln to the hot air inlet end. These kilns are narrow tunnels holding 16 cars; a temperature of 140° is maintained, and the heated air enters at one end and is drawn out at the other. The starch, containing about 10 per cent of moisture, is powdered either by rolls or beaters and then passed through silk bolting machines. Pearl starch is that which is not milled after drying but is sold in small masses of a pseudo-crystalline structure. The starch before sending to market is either sacked or barreled.

The 24° Baumé starch is pumped into the refinery breakers, where it is mixed with one fourth of 1 per cent concentrated muriatic acid, and is pumped into the converters. The converters are horizontal copper cylinders, 6 by 20 feet, holding 2,000 gallons of starch liquor. A perforated steam coil is in the bottom of the converter and a similar perforated

pipe in the top is the inlet for the starch. Before pumping in the starch the steam coil is covered with an acidified water which is brought to a boil. The starch is pumped in, just fast enough not to cool the water below the boiling point, under a pressure of 20 pounds to the square inch. When all of the starch is in the converter the pressure is raised to 35 pounds, and is held at this for twelve minutes, or until the desired sodine test for glucose containing 55 per cent of dextrose is obtained. For acme sugar containing 85 per cent of dextrose the starch is diluted to 14° Baumé and held at a pressure of 45 pounds for forty five minutes. For brewing sugar containing 93 per cent of dextrose the starch is diluted to 18° Baumé and held at a pressure of 40 pounds for twenty minutes.

The conversions are forced into blow up tubs, which are large open tubs for relieving the pressure on the converters. From these tubs it flows into neutralizers, where all but 0.015 per cent of the acidity is neutralized with soda ash. From the neutralizers the liquor enters settling tanks for the removal of the coagulated gluten and fibrous matter or it is pumped into regular sugar presses at once.

The liquors from the presses are passed over or through boneblack until all of the color is removed. These filters are horizontal cylinders, 20 by 6 feet, filled with animal black. The liquor enters at the top and is drawn out at the bottom. The filters will usually run from fifteen to eighteen hours. From the filters the liquor is drawn into vacuum pans and is evaporated under 27° to 30° Baumé. From the vacuum pans the liquor is passed through another set of black filters to remove the color that has been generated in the evaporation. These filters are like the first filters, but contain freshly burned black and are only run four hours. After this liquor has exhausted the black it is used for light liquors. From the filters the liquor is drawn into the finishing pan and evaporated to the required density. For glucose either 41°, 42°, 43°, 44°, or 45° Baumé are required. For 70 sugar 41° and for acme or 80 sugar 45° Baumé are required. All weighings are made at 100° F. The pans are regular sugar vacuum pans holding about 63 pounds of glucose.

The glucose from the pans is run into cone bottom iron tanks fitted with cooling pipes. After cooling the glucose to 100° F., a little bisulphite of soda is added to prevent fermentation, and a little aniline violet to neutralize any tinge of yellow. The glucose is drawn into barrels, and sold at 1 to 1½ cents per pound.

The sugar from the vacuum pans in the case of 70 sugar is drawn into a cooler, and to it are added several buckets of previously crystallized sugar. In this way crystallization is induced. The sugar is then drawn into barrels or pans, where it crystallizes and becomes solid in eighteen hours at normal temperature. The acme is handled in the same manner, but is all crystallized in pans in a room heated to 115° F. Thirty six hours are required for the acme crystallization, and then thirty six hours more in a cold room for curing. The panned sugar is chopped and sold in bags. Anhydrous sugar is handled much in the same way as the other, only that the starch is diluted to 1½° Baume and the plextrose is carried to the maximum. The crystallization is done in cones or forms in a hot room. The cones are made to fit a centrifugal, in which the sugar is freed from adhering sirup. The sugar is shaved and air dried for several days, and is sold in barrels at 4½ to 5½ cents per pound.

The so-called gluten drawn from the tabled starch is first settled for five hours in wooden tubs, and then the concentrated mass is further concentrated in cone settlers. It is then mixed with the feed and sent to the presses. The steep water from the steeps is first acidified with sulphuric acid to remove the sulphurous acid. It is evaporated to 10° Baumé and neutralized with milk of lime. The precipitate formed is removed by filter presses. The liquor is then evaporated to 30° Baumé and again mixed with the lime precipitate. It is then mixed with the pressed feed.

In the above description no attempt has been made to go into the details of the manufacture, but simply to give the general principles which are followed. In different factories different details of manufacture would be found, but in general the large factories making Indian corn starch follow essentially the methods given above.

The principles underlying the manufacture of starch from the potato are very simple in their mechanical application. The problem is very much less complicated than in the case of Indian corn, since there are no by-products which are worth saving except the pulp, hence no apparatus is necessary for the removal of the outer hull or of the germ. Potatoes of all sizes are used, but chiefly what is known as the culls or immature tubers, or those which are injured in digging and are unsuitable for sending to the market for food purposes. The state of the markets is usually such that there is more profit in selling well formed and mature potatoes of good size for direct consumption than there is in sending them to the starch factories.

Usually when the price of good, marketable potatoes approaches $1 per barrel, farmers find it more profitable to sell for direct consumption. In a personal inspection of the potato starch industry in Aroostook county, Maine, potatoes fit for consumption on the table were selling for a dollar a bushel, while the starch manufacturers were paying only from 30 cents to 60 cents per bushel for potatoes used in the manufacture of starch. It is evident that the quantity of starch in such potatoes is very much inferior to that in the merchantable potatoes sold at a higher price. The yield of commercial starch varies from 10 to 16 per cent of the weight of the potatoes used, according to the character and grade of the raw material employed. In Germany potatoes particularly rich in starch are grown especially for starch making. It is not a matter of wonder, therefore, that the yield of starch from the American factories is lower than from the German factories for the same weight of potatoes.

The process of manufacture of potato starch is very simple; in fact the housewife can make a very good potato starch by rasping the potato on a piece of sheet iron punctured with numerous holes by an ordinary awl, throwing the pulp upon a fine cloth and washing the starch through with a stream of water.

THE BEEF INDUSTRY.

BY JAMES R. GARFIELD.

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At the present time a large proportion of the supply of both fresh and cured meats for the whole country is produced by huge establishments situated in a comparatively few cities in the middle west. In the early days, cattle, hogs, and sheep were for the most part slaughtered at or near the places where their flesh was consumed. The most important of the causes which have brought about this great change in the meat industry are the following:

Westward movement of the live stock industry, and the consequent increase in the distance separating the place of production of live animals from the place of consumption of a large part of the meat.

Improvement in methods of preserving and transporting meats, especially the introduction of refrigeration.

Economies and advantages of marketing live stock at a few centers, and of slaughtering in large establishments. While the possibility of securing these advantages was a cause tending to drive the packing industry toward the west, they are also, of course, to be viewed as results of the concentration of the industry in western centers.

The development of manufacturing industry in our eastern states and the consequent rapid growth in their population long since brought it about that the farms of those states could not supply their people with agricultural products. The west has become more and more each decade the source of raw material for the nation's food supply. This is even more true of live stock than of grain. The center of live stock production has steadily moved toward the west. The increased demand for agricultural foods has necessitated resort

to more intensive methods of cultivation and has led to the conversion of pastures into cultivated fields. The raising of cattle and sheep, which, more than that of swine, demands grazing land, has been steadily pushed westward, till at present the great pastures of the country are 2,000 miles or more from the eastern seaboard. The center of the production of corn and hay has moved from the eastern states to the fertile prairies of the Mississippi valley, and that section has therefore become the chief source of supply of the fat cattle and hogs which are fed upon these crops. With the increasing demand for meats in the great cities of the east, it has been necessary to bring a constantly growing proportion of the supply from long distances. Naturally it was sought to reduce the cost of transportation, so far as possible, by substituting dressed meats for the more bulky and less valuable live animals. The slaughtering business thus tended to move westward with the live stock industry.

The imperfection of the earlier statistics of live stock makes it impossible to show adequately by figures the extent of the change in the geographical distribution of the stock raising business. The number of all cattle reported on farms and ranges January 1, 1905, was 17,572,464 milch cows valued at $482,272,203, and 63,669,443 other cattle, valued at $661,571,308.

January 1, 1905, the number of sheep in farms and ranges was 45,170,423 valued at $127,331,850 and of swine 47,320,511, valued at $283,254,978.

In one year the milch cows had increased by 152,647 head, the other cattle 39,945. The number of sheep fell off in 1904 6,459,721, but the swine had increased 311,144 head.

As the center of live stock production shifted toward the west, it became necessary, in order to provide eastern cities with meat, either to transport live animals for long distances, or to devise methods by which the meat derived from stock slaughtered in the west could be preserved during transportation. On account of the greater shrinkage and deterioration which live hogs suffer it is much more difficult to transport them than live cattle. On the other hand, cured pork products are much more satisfactory for consumption than cured

beef or mutton; most parts of the hog are indeed better when cured than when fresh. It is not surprising therefore that, until the introduction of refrigeration, the packing of hog products was a much more extensive industry than the packing of beef or mutton.

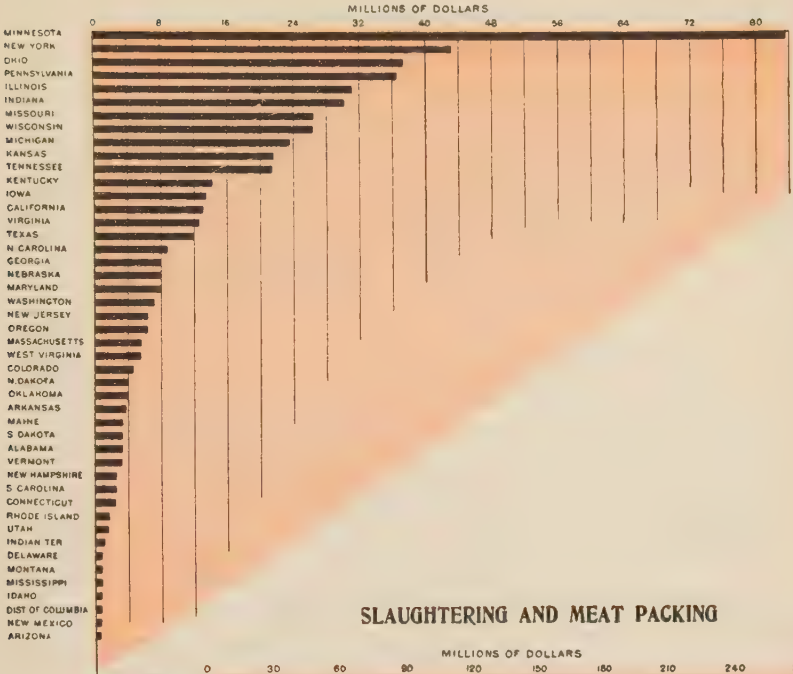
As early as the second quarter of the nineteenth century the packing of hogs became an industry of considerable importance in the region between the Allegheny mountains and the Mississippi river. Cincinnati was long the leading center of this business. The hogs slaughtered at Cincinnati in the season 1848–49 numbered 475,000. The industry of hog packing grew steadily, and before 1870 had become one of the most conspicuous industries of Chicago, St. Louis, and several other cities of the central west.

At this time also a considerable amount of salted beef was produced in the same section for consumption in the east. But much the greater part of the demand for beef in eastern cities was still supplied by local slaughtering. It was not until the introduction of economical methods of mechanical refrigeration and the invention of the refrigerator car that it became possible to bring fresh meats from distant places. A refrigerator car was patented in 1868, and in September, 1869, the first consignment of fresh beef was shipped from Chicago to Boston. From this time the modern packing industry may be said to date, although fresh meat was not supplied in large quantities till several years later. It was cheaper to kill live stock in the west, near the main source of supply, than to carry them east for slaughter. The most important saving was in freight charges, only the valuable part of the animal now being transported, without the waste. The weight of the beef derived from a steer averages only about 55 per cent of the live weight. Moreover, the shrinkage in the weight and the frequent deterioration in the quality suffered by live animals during long railway journeys are avoided by slaughtering them in the west.

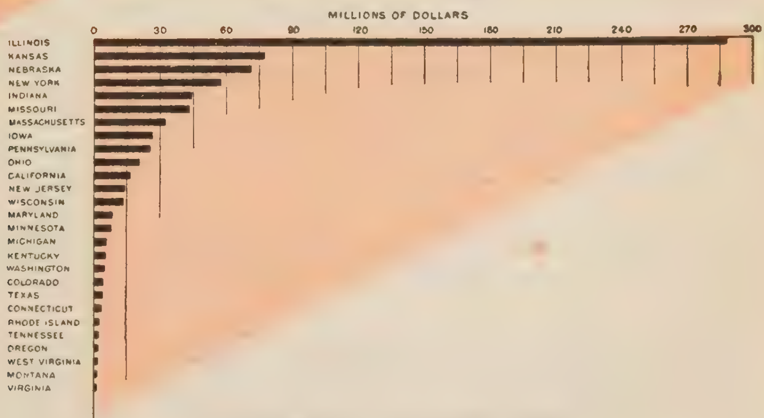
The influence of the introduction of refrigeration is seen conspicuously in the subsequent rapid increase in the number of cattle and sheep killed at Chicago, at which city the method was first extensively developed. The number of cattle

VALUE OF PRODUCTS OF SELECTED INDUSTRIES

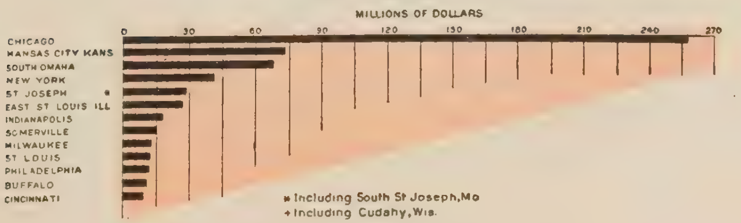
FLOUR AND GRIST MILL PRODUCTS



SLAUGHTERING AND MEAT PACKING



SLAUGHTERING AND MEAT PACKING FOR THIRTEEN CITIES.



slaughtered in Chicago rose from 224,309 in 1875 to 495,863 in 1880, and to 1,161,425 in 1885. The transportation of mutton in refrigerator cars began somewhat later than that of beef. The number of sheep slaughtered in Chicago was only 179,292 in 1880, while by 1885 it had risen to 743,321, and by 1891 to about double that number.

The gradual westward movement of the chief areas of live stock production has drawn the packing houses in its train. The supremacy as a packing center which first fell to Cincinnati, was surrendered to Chicago about 1860, and the latter city still maintains its leadership over all others in this respect.

Beginning about 1870, St. Louis and East St. Louis came swiftly forward as a seat of the meat packing industry. Kansas City, which was situated still nearer than St. Louis to the ranges of the west and the great corn fields of Kansas and Nebraska, became an important packing center about 1880. By 1890 more cattle, hogs, and sheep were slaughtered in Kansas City than in St. Louis, and at the present time the business in Kansas City considerably exceeds that in any other packing center except Chicago, and is nearly half as great as that in Chicago itself. Omaha, bearing a relation to the northwest similar to that borne by Kansas City to the southwest, began to slaughter live stock about 1885. Its business has likewise grown with great rapidity, and at present Omaha and St. Louis are close rivals for the third rank among the packing centers.

The industry was established at St. Joseph, Mo., in 1897, when two of the leading Chicago packers erected large plants there.

The manner in which these five great packing centers have successively developed may be viewed statistically by means of the table, which shows for each the number of cattle, hogs, and sheep slaughtered in 1870, and every fifth year thereafter up to 1900, together with the corresponding data for 1903. The statistics prior to 1900 represent the difference between the receipts and shipments of each year; this number is nearly, though not precisely, the same as the slaughterings, the discrepancy being due to the small number of animals

carried over in the stock yards at the end of the year. The data for 1900 and 1903, however, represent actual slaughterings.

NUMBER OF CATTLE, HOGS, AND SHEEP SLAUGHTERED AT EACH OF THE FIVE LEADING PACKING CENTERS.

Kind.	Year.	Chicago.	Kansas City.	South Omaha.	East St. Louis.	South St. Joseph.
Cattle	1870	141,255	....	....	71,674	....
	1875	224,309	48,492	....	119,041	....
	1880	495,863	50,288	....	195,841	....
	1885	1,161,425	104,246	30,930	153,071	....
	1890	2,223,971	548,677	322,819	277,309	....
	1895	1,803,466	893,750	314,312	578,419	....
	1900	1,794,397	1,092,804	516,669	488,008	288,977
	1903	2,163,031	1.025,446	735,158	870,760	404,737
Hogs	1870	768,705	....	....	293,694	....
	1875	2,329,467	47,560	....	501,840	....
	1880	5,664,365	523,557	....	1,069,915	....
	1885	5,140,089	1,557,556	58,948	666,048	....
	1890	5,678,128	2,306,944	1,397,676	694,320	....
	1895	5,784,670	2,171,357	1,087,716	834,862	....
	1900	6.656,881	2,827,128	2,162,612	1,643,411	1,537,582
	1903	6,088,369	1,891,708	2,177,981	1,518,898	1,577,860
Sheep	1870	233,142	....	....	82,828	....
	1875	175,344	7,585	....	87,895	....
	1880	179,292	14,326	....	112,447	....
	1885	743,321	106,046	10,577	129,467	....
	1890	1,252,813	199,662	61,722	106,768	....
	1895	2,932,093	577,419	94,840	391,515	....
	1900	3,061,631	636,018	728,523	359,034	290,590
	1903	3,582,651	775,989	881,359	481,938	442,717

While Chicago, St. Louis, Kansas City, Omaha, and St. Joseph have thus become the leading western seats of the meat slaughtering industry, other cities in the central west have also developed a very considerable business in the packing of hogs, though they are of minor importance in the slaughter of cattle and sheep. Among these may be mentioned Indianapolis, Louisville, Cedar Rapids, Des Moines, Sioux City, and St. Paul. The most recent development is the establishment of large packing plants at Fort Worth, Tex., much nearer than Kansas City to the great cattle ranches of the southwest.

A broad statistical view of the westward movement of the slaughtering industry may be gained by comparing, at different periods, the combined receipts of live stock at New York, Boston, Philadelphia, and Baltimore, on the one hand, with the combined slaughterings of live stock at Chicago, St. Louis, Kansas City, Omaha, and St. Joseph, on the other. The number of cattle slaughtered in the western cities is obtained by adding the figures for the individual cities. In

judging of the figures for cattle, however, it should be borne in mind that a considerable and increasing proportion of the live cattle received at the eastern ports are exported alive to Great Britain.

COMBINED RECEIPTS OF CATTLE, HOGS, AND SHEEP AT NEW YORK, BOSTON, PHILADELPHIA, AND BALTIMORE, COMPARED WITH COMBINED SLAUGHTERINGS AT CHICAGO, ST. LOUIS, KANSAS CITY, OMAHA, AND ST. JOSEPH, FOR SELECTED YEARS, 1870–1903.

Year.	Cattle.		Hogs.		Sheep.	
	Receipts at 4 eastern markets.	Slaughterings at 5 western markets.	Receipts at 4 eastern markets.	Slaughterings at 5 western markets.	Receipts at 4 eastern markets.	Slaughterings at 5 western markets.
1870 *a*	701,427	212,929	1,568,455	1,062,399	2,771,875	315,970
1875 *b*	867,851	391,842	2,243,437	2,878,867	2,289,263	270,824
1880 *b*	1,267,641	741,992	3,094,803	7,257,837	2,489,936	306,065
1885 *c*	960,956	1,449,672	3,301,232	7,422,641	3,284,409	989,411
1890 *c*	1,240,218	3,372,776	4,659,880	10,077,068	3,274,327	1,620,965
1895 *c*	1,003,090	3,589,947	4,134,253	9,878,605	4,224,586	3,995,867
1900	1,099,269	4,180,855	3,925,718	14,827,614	3,074,244	5,075,796
1903	966,239	5,199,132	3,603,694	13,254,816	3,252,567	6,164,654

a Western cities: Chicago and St. Louis only.
b Western cities: Chicago, St. Louis, and Kansas City only.
c Western cities: Chicago, St. Louis, Kansas City, and Omaha only.

This table shows that, despite the enormous increase in their population, the receipts of cattle at the leading eastern seaboard cities in 1903 were only about one third greater than in 1870, and that since 1890 there has been an absolute decrease of nearly one fourth in the receipts. On the other hand, the number of cattle slaughtered in the five western cities in 1903 was twenty five times greater than in 1870 and nearly three fifths greater than in 1890. In 1870 the cattle received at the eastern cities were nearly three and one half times as numerous as those slaughtered in the western cities. In 1890 the eastern receipts of cattle were only about 37 per cent as great as the slaughterings in the western centers, and by 1903 the proportion had fallen to less than one fifth.

The number of hogs received at the four seaboard cities was about two and one third times greater in 1903 than in 1870, but as compared with 1890 there had been a decrease of about one fourth. The number of hogs slaughtered at the five western cities, however, was about thirteen times greater in 1903 than in 1870 and nearly one third greater than in 1890. In 1870 the receipts at the eastern cities were approximately

one half greater than the slaughterings in the western cities. In 1903 the eastern receipts were equal to only 27 per cent of the western slaughterings.

The number of sheep received at the four eastern seaports in 1903 was only about one sixth greater than in 1870, and was nearly one fourth less than in 1895. The sheep slaughtered at the five western cities were nearly twenty times as numerous in 1903 as in 1870, the increase in slaughterings after 1890 being especially great. In 1870 the sheep received at the eastern cities were to those slaughtered in the western centers as nine to one. In 1903 the ratio was as one to one and nine tenths.

Another view of the preponderating importance of the five great western packing centers with respect to the beef industry is gained from the table which shows for the year 1903 the difference between the receipts and shipments of cattle, corresponding closely, except as to the eastern seaports, with the number slaughtered, at all points for which systematic statistics are kept. At several other cities, including Pittsburg, Lincoln, Pueblo, and others, records are kept of cattle receipts, but not of shipments. Since it is known that most of the cattle received at these places are shipped elsewhere and not slaughtered locally, their receipts are omitted from the table. A large proportion of the receipts of cattle at the eastern seaboard cities mentioned in the table are exported alive, but the total receipts, without deducting such exports, are shown in the table.

NUMBER AND PERCENTAGE OF CATTLE SLAUGHTERED (AS INDICATED BY DIFFERENCE BETWEEN RECEIPTS AND SHIPMENTS) AT LEADING CITIES, 1903.

CITY.	Number.	Per cent.	CITY.	Number.	Per cent.
Chicago	2,163,031	32.17	South St. Paul	72,215	1.07
Kansas City	1,033,384	15.37	Sioux City	70,331	1.05
St. Louis and E. St. Louis	846,783	12.59	San Francisco	66,390	.99
Omaha	769,826	11.45	Louisville	61,848	.92
St. Joseph	404,232	6.01	Baltimore	54,872	.82
			Detroit	45,790	.68
Total for western cities	5,217,256	77.59	Cleveland	43,489	.65
			Milwaukee	39,514	.59
Fort Worth	292,686	4.35	Denver	39,139	.58
Indianapolis	158,357	2.36	Jersey City	26,835	.40
Cincinnati	150,952	2.24	Portland, Oreg	7,319	.10
New York	127,350	1.89	Boston	56,867	.89
Philadelphia	102,558	1.53			
East Buffalo	87,296	1.30	Total for U. S.	6,724,064	100.00

The statistics of the slaughtering and packing of hogs are more complete than those regarding cattle. The annexed table shows for the years ending March 1, 1903 and 1904, respectively, the number of hogs packed at the five leading western centers, in comparison with the total number for which statistics exist and with the number packed at certain other individual cities.

NUMBER OF HOGS PACKED AT THE FIVE LEADING WESTERN PACKING CENTERS AND AT OTHER PACKING CENTERS, YEARS ENDING MARCH 1, 1903 AND 1904.

CITY.	Year ending— March 1, 1903.	Year ending— March 1, 1904.
Chicago	6,860,453	6,713,086
Kansas City	2,055,942	2,086,550
Omaha	2,004,826	2,173,734
East St. Louis	1,262,358	1,570,744
South St. Joseph	1,528,860	1,609,185
Total for five cities	13,712,439	14,153,299
Indianapolis	930,000	1,123,665
Sioux City	777,320	467,595
St. Paul	715,237	810,988
Milwaukee and Cudahy	553,986	846,287
Cleveland	521,672	625,803
Cincinnati	498,376	585,873
Ottumwa, Iowa	441,680	486,991
Cedar Rapids, Iowa	391,524	501,789
Louisville, Ky	323,940	319,969
Nebraska City, Nebr	209,835	238,707
Total for fifteen centers	19,076,009	20,160,966
Other western cities	1,529,562	2,214,720
Total western packing	20,605,571	22,375,686
Boston	1,450,000	1,251,986
Minor eastern cities	1,345,504	1,529,197
Total eastern packing	2,795,504	2,781,183
New York receipts	1,031,559	1,563,704
Philadelphia receipts	215,892	217,726
Baltimore receipts	598,284	679,286
Total receipts for three cities	1,845,735	2,460,716
Total eastern	4,641,239	5,241,899
Total western	20,605,571	22,375,686
Aggregate	25,246,810	27,617,585

This table shows that there is a much wider distribution of the hog slaughtering business than of the cattle slaughtering business. The five leading western centers—at each of which (except St. Louis) more hogs are slaughtered than at any other single city outside of this group—did 54.31 per cent of the total packing in the season of 1902–3 and 51.27 in the

season of 1903–4. At other western points 27.3 per cent of the total number of hogs were slaughtered in 1902–3, and 29.8 per cent in 1903–4. Aside from Indianapolis, Sioux City, St. Paul, and Milwaukee, there are six minor western packing points at each of which more than 200,000 hogs are slaughtered yearly. Those six are, in the order of their importance, Cleveland, Cincinnati, Ottumwa, Iowa; Cedar Rapids, Iowa; Louisville, and Nebraska City, Neb. Boston is still an important hog packing center, while the hogs received at New York, Philadelphia, and Baltimore are largely slaughtered for consumption in the fresh state.

In the following brief description of the modern methods of business in the slaughtering and marketing of meat products, reference is had particularly to the establishments in the larger western cities which are operated by the six leading companies—Armour & Co., Swift & Co., Morris & Co., The National Packing company, The Schwarzchild & Sulzberger Co., and the Cudahy Packing company. It is peculiarly characteristic of these companies that each has plants in three or more cities, and that each handles alike cattle, hogs, and sheep in large numbers. There are besides, in the same cities and elsewhere in the central west, many smaller concerns, most of which have only a single plant, and many of which are confined to the hog branch of the industry. Though the aggregate number, particularly of hogs, slaughtered by all of these minor concerns combined is of great importance, no one of them can compare with the leading companies in the amount of even the hog business which it handles.

The most important breeding grounds for cattle at present are the great ranches and the free public lands of the far western plains and of the Rocky mountains. Texas produces more cattle destined ultimately for slaughter than any three other states. The prevalence of Texas fever and other diseases in the southern part of this state and in adjoining states has led the United States bureau of animal industry to establish a quarantine line. The marketing of cattle below this line is subject to certain restrictions during part of the year, and they may not be sent into other states for feeding or breeding purposes. Many cattle not subject to quarantine

are sent from the southwest, usually at the age of two years, to the ranges of Montana and South Dakota, where they are generally kept two years before marketing. A large number of grass fed cattle from all of the ranch and range states, whether raised there or brought thither for feeding, are sent directly to the packing centers for slaughter. The slaughtering of such cattle is largely confined to the fall months.

Thousands of cattle from all the farther western states above the quarantine line are yearly shipped to the corn raising states of the central west to be fattened. Much the larger part of the supply of cattle for slaughter at the packing centers consists of corn fed animals from these states, of which Illinois, Iowa, Kansas, Missouri, and Nebraska are the most important. Such cattle are known as natives. Very few hogs are raised on the ranches and ranges of the far west. Much the greater proportion of the hogs coming to the packing centers are both raised and fattened in the central corn belt.

The free ranges of the mountain states are the most important source of the supply of sheep. Only to a small extent are lambs from this section brought to the corn belt for fattening. A great number of spring lambs are marketed for slaughter in the fall and winter, while others are kept till they are older before being slaughtered.

In the transportation of live stock both humanity and economy demand that the animals shall be kept in the cars as short a time as possible. They are therefore ordinarily shipped in special stock trains, the speed of which often approaches that of passenger trains. Each car is usually loaded to its full capacity, the consignments of two or more shippers being combined, if necessary, to secure that end. A large proportion of the hogs and sheep are carried in double deck cars, the upper floor of which is movable. The animals may be fed and watered by means of troughs along the side of the cars; but if the journey is a long one they are unloaded one or more times for food and rest. Shippers must furnish their own men to care for the animals en route. In many cases the owner accompanies his stock to assist in selling it.

At each of the leading packing cities large central stock yards have been established. To these yards nearly all the

live stock coming to the city is brought for sale. In this way all sellers and buyers are brought together—a fact which, so long as there is no combination on either side, makes the market a broad and normal one, and tends to fix prices for all animals at the level dictated by the general conditions of supply and demand. These central stock yards, too, are able to offer facilities for the prompt and convenient handling of stock such as could not be afforded by smaller yards scattered in different parts of the city and its suburbs.

It is the aim of the shippers, and at least in theory that of the railway companies, so to time the loading of cars and the movement of trains that the stock shall arrive at the yards early in the morning, in time for the day's market, which is ordinarily confined largely to the forenoon. The animals are quickly unloaded and driven to the selling pens, where they are fed and watered. Shippers find themselves virtually compelled to intrust their stock to a commission agent for sale. All regular commission dealers are members of an organization or exchange, which fixes the minimum charges for selling stock, and which aims to enforce fair and honest methods on the part of its members. The actual sale of stock takes place at the pens. Each of the great packing companies has several buyers, each of whom is usually confined to one class or grade of animals, regarding which he becomes an expert. There are, besides, in all of the markets a certain number of buyers for smaller local concerns, buyers for eastern concerns or special order buyers, and export buyers. The latter purchase cattle for shipment alive to Europe. These special classes of buyers are more numerous at the Chicago market than elsewhere.

Animals are sold in bunches varying in number from one to several hundred. The consignment of each shipper is ordinarily sold separately, and such a consignment may be subdivided by the commission agent, either for the purpose of adjusting the number sold to the demands of the individual buyers, or, more commonly, in order that an approximate uniformity in character and quality may be secured among the animals in a given bunch. Such uniformity makes it easier to determine the value of the bunch than would be the

case if the animals were mixed. This classification for the purpose of sale, which is made sometimes at the instance of the buyers, but more often at that of the salesman, is most conspicuous in the case of cattle. A mixed shipment of cattle is usually divided according to sex; cows are separated from heifers, bulls and stags from steers, and often there is a further subdivision of steers according to age or quality. Sometimes all the different bunches thus made out of one shipment are sold to one buyer; sometimes they are sold to different buyers.

When a bunch of cattle, hogs, or sheep is sold, it is driven to the scales to be weighed. The great packing houses are ordinarily situated in or near the stock yards, and animals bought by the packers can thus readily be driven to them. Cattle are frequently held a day, or even more, in order that they may rest and that their temperature, raised by the journey, may be reduced to the normal point. Hogs and sheep are usually killed on the day of purchase.

The modern packing plant is a huge establishment, consisting of many buildings, large and small, each adapted to some special purpose. A central power plant furnishes light, heat, and power, consuming hundreds of tons of coal daily and generating thousands of horsepower. Machinery is used for every process to which it can be applied, but in many parts of the slaughtering industry machine work is obviously out of the question. Among the many ingenious mechanical devices may be mentioned the scraping machine for removing the bristles from hogs. Blades mounted on cylinders come automatically in contact with every part of the body and do the work with rapidity and perfection.

Animals are usually killed at the top of a building from four to six stories high, in order that, as they proceed through the various stages of dressing, they may be moved forward, so far as possible, by gravity. For this purpose overhead rails are used.

The most conspicuous fact which strikes one in observing the process of slaughtering and dressing is the remarkable extent to which the division of labor is carried. In the old fashioned small slaughterhouse one man, or at most a very

few men, performed all the tasks from the dealing of the death blow to the final preparation of the carcass for sale. In the largest slaughtering plants of to-day will be found hundreds, or even thousands, of workmen, each of whom performs but a very small, narrowly defined task, in which by innumerable repetitions he becomes adept.

A concrete illustration will serve to show more clearly this high subdivision of labor. At one of the great abattoirs in Chicago 157 men are employed in one of the beef killing gangs. All these men are engaged in handling the cattle killed by two knockers and one sticker. The number includes all those conducting the processes from the driving up of the cattle to the loading of beef into the cars, but does not include the men who operate the power plants, refrigerating machinery, etc., nor those who handle by-products, even those by-products which are sold in a fresh condition. These 157 represent no less than 78 different occupations; that is, the work of killing and dressing of cattle and refrigerating and loading beef is subdivided into 78 distinct processes. A gang of men thus organized can handle more than a thousand cattle in a day of ten hours. Some of the packing houses have two or more such cattle killing gangs. In the hog and sheep slaughtering departments the division of labor is carried to a similar degree of minuteness, and the same is true of those departments which can and cure meats, and which handle or manufacture the various by-products.

The leading packers keep a record of the dressing results of each individual bunch of animals slaughtered. Perhaps usually each bunch so recorded represents the stock bought by a single buyer from a single seller, being one of the original selling bunches above described. Several small bunches as bought are, however, often combined to constitute a single killing bunch, and some of the packers carry this practice of combining bunches much farther than others. For each killing bunch of cattle the packer ordinarily records the live weight, live cost, dressed weight, weight of each class of hides, and weight of the caul and ruffle fat, which is easily detached and readily weighed. From these data the packers compute what they call the dressed cost per hundred pounds of

beef. Somewhat similar methods are pursued with reference to hogs and sheep. The so-called dressed cost of beef, as figured by most of the large packers, much exceeds the true cost which would be found by allowing a full value for the by-products. The arbitrary dressed cost has, however, much value to the packer for the purposes of comparison, and serves as a check upon both buyers of stock and sellers of meat. The record of the number, origin, and dressed cost of each bunch of animals is preserved until the meat is sold or otherwise disposed of.

In the large wholesale slaughtering establishments all the meat which is to be sold fresh is either chilled or frozen by artificial refrigeration. Much the greater proportion of the cattle and sheep slaughtered are sold in the fresh state; but in the case of hogs it is usually the custom to cut out the loins for sale as fresh meat and to cure the remainder of the flesh. Only when it is intended to keep meat fresh for a period of several weeks or months is it frozen. In that state it will keep almost indefinitely, but when thawed it is not so good as chilled meat, and it will keep only a short time after thawing. The most important application of the freezing process is to the better cuts—ribs and loins—which are taken from the poorer grades of cattle, of which the remaining parts are used for canning or salting.

In chilling meat the carcasses or cuts are hung in large rooms cooled by the presence of cold pipes or by a blast of air which has passed over coils of such pipes. The refrigeration machinery of a large packing plant is on a very extensive scale. The reduction of the temperature of the meat must be gradual if the best results are to be attained. Chilled meat is not ordinarily shipped till at least twenty four hours after it has been slaughtered. The temperature finally reached is just above freezing point. If kept at this temperature meat will remain in good condition for about three weeks, and is indeed best ten days or two weeks after it is killed.

In the early days of the beef packing industry, the entire product was salted. Even for some time after the introduction of refrigeration, the salting of beef was still conducted on a large scale, but more recently salt beef has been largely

replaced by refrigerated fresh beef or by canned beef. According to the census reports the salt beef produced by wholesale slaughtering and packing establishments in 1890 was equal in weight to about one fifth of the fresh beef produced by such establishments in that year; but in 1900 the proportion had fallen to less than one twentieth, the amount of salt beef having decreased from 576,289,731 pounds to 137,589,303 pounds. The canning of beef on a large scale began about 1880, when improved processes were invented. The business has, however, fallen off somewhat since 1890. The production of canned beef according to the census of 1900 was 112,449,221 pounds, as compared with 2,920,458,297 pounds of fresh beef. The cattle used for canning and salting are inferior to those used for fresh beef, consisting largely of cows and to some extent of ranch and range steers. Mutton is not ordinarily salted, cured, or canned. On the other hand, much the larger part of the hog product is either salted or sweet pickled and smoked. The distinctions among the various cuts of pork, and among the methods of preserving them, are many and complex. Different markets in this country and in Europe demand different methods of cutting and preparing the carcass. The process of salting and curing pork products requires considerable time, and, since the products may be preserved almost indefinitely, the relation between the prices of live hogs and those of the meats derived therefrom is much less close than the relation between the prices of live cattle and fresh beef.

The more important packing establishments themselves salt and cure a large proportion both of their beef and their hog products which are to be so handled, carrying them to the final stage of readiness for consumption. They manufacture their own cans, print their own labels, and to a large extent make their own boxes, tierces, and barrels. Some of these concerns have also developed an extensive business in the production of canned specialties ready for the table, including soups, entrees, etc. A very important branch of the business of the great packers is the making of sausages, of which there is a bewildering variety. To the sausage department go pieces of meat trimmed from the various cuts,

or from those parts of the animal, such as the heads, which can not be marketed directly for food. The greater proportion of the sausage meat is derived from hogs. The output of sausage as reported by the census of 1900, by wholesale establishments, was no less than 292,164,075 pounds.

The rendering of lard is one of the largest branches of the hog industry. The methods of rendering used by the leading packing concerns have reached a remarkably high degree of perfection. Some of the packers also produce various lard compounds by mixing refined lard with stearin, cotton seed oil, and other materials.

When fresh beef, mutton, or pork has been chilled to the proper temperature it is loaded into refrigerator cars in which a uniform temperature, about freezing, is maintained by the use of ice and salt. Fresh beef and mutton are usually shipped in the form of whole sides or quarters, but at times a demand for special parts of the carcass in a particular market leads to the cutting of the meat before shipment. A large proportion of salted and cured meats are also transported in refrigerator cars, but these are iced without salt, a moderately low temperature only being required. Refrigerator cars must be re-iced every day or two on their journey. This is done by the shippers, the larger companies maintaining icing stations at various points for that purpose.

So great is the movement of meat products from the western packing centers to the leading eastern markets that solid trains of refrigerator cars are usually forwarded. These run at a relatively high speed. The time required between Chicago and New York, for example, is usually four or five days.

The great packing companies all own large numbers of refrigerator cars, the railroad companies seldom owning cars intended for the transportation of meats. The shipper pays the ordinary freight rates on his product, but is in turn paid a rental by the railroad for the use of his cars. The ordinary payment by the eastern lines is three fourths of a cent per mile run, while in the west the prevailing rate is 1 cent per mile. Two of the leading packing companies have extended their refrigerator car business into other fields, and now furnish the cars for the transportation of enormous quantities

of poultry, dairy products, vegetables, and fruits. The companies have also become, as a result, extensive dealers in such articles, especially poultry, dairy products, and eggs.

The leading packing companies, either directly or by subsidiary or allied companies, own distributing houses in most of the leading cities of the country and in many of the towns of medium size. To some extent, however, the companies consign beef to large commission houses in which they have no proprietary interest. In the larger cities each great packer has usually several branches, known to the trade as coolers or boxes. The products are transferred from the cars to these branch houses, where the fresh meat is kept chilled until sold. The retail dealer who desires to buy comes directly to these branch houses and selects what he wants. In the marketing of beef there is the widest difference with regard to the character of the pieces sold. A large proportion of the carcasses are sold as sides, but many retail dealers desire special parts, so that other carcasses are cut, and that in a variety of ways. On account of their perishability the handling of fresh meats is a peculiarly delicate business. The packer aims to get as high a price as possible, but he must sell the entire product before it spoils. Differences in quality of animals and of their products are so great that the closest supervision of the central office is necessary to enforce the exercise of skill and sound judgment on the part of the agents who buy stock and the agents who sell meats. With this object, those branches of the selling and accounting department of the packing companies which have charge of the purchasing, killing, dressing, and selling of fresh meats are organized in a most extensive and thorough manner. The central office is in constant telegraphic correspondence with the distributing houses, with a view to adjusting the supply of meat and the prices as nearly as possible to the demand.

The most important respect in which the slaughtering and packing industry of the present day differs from that of earlier times is in the utilization of those parts of the animals which do not constitute dressed meat. Formerly these parts of the carcass were thrown away, or they were handled in a summary manner and their products were utilized in a very

imperfect condition. At present the products derived from such parts, which may be designated as by-products of the packing industry, are numbered by scores, and the most elaborate processes are used in deriving and perfecting them. It is often stated that in the by-products is to be found the profit of the packing business. This statement is true in the sense that, under ordinary conditions, there would be no profit, but on the contrary a decided loss in the prevailing margin between the prices of live animals and those of dressed meat, were it not for the value of the by-products. It is, however, an incorrect way of looking at the matter to say that under such circumstances the meat is sold at a loss, which is made up from the by-products.

The investigations of the bureau of corporations indicate that the margins between prices of stock and prices of meats have been kept during recent years, by reason of the thorough utilization of by-products, at a point lower than would have been possible under the methods of slaughtering and packing which prevailed thirty or more years ago. By virtue of the economies secured in the handling of former wastes, and in other ways, the development of huge packing establishments has beyond question been beneficial to cattle raisers and meat consumers.

When the slaughtering business first became established on a large scale there grew up in the vicinity of the packing plants independent establishments, the function of which was to handle the by-products collected from the packing houses. Glue works, fertilizer works, soap factories, oil and tallow works, and the like were in large measure separate from the slaughtering concerns. As the packing business became more concentrated in the hands of a few large companies, these gradually—but finally almost completely—took over the allied industries, affecting various important economies in such unification. At present the leading packers themselves carry the elaboration of almost every possible by-product to an advanced stage.

The aim is, ordinarily at least, to advance the product to a condition where it will encounter a wide competitive demand; but often the process of elaboration is carried further than is

necessary for this purpose and the commodity is put into the form at which it is finally to be consumed. In such a case the packer enters into an industry not essentially part of the packing business, and often in competition with other concerns which do no packing business.

The leading packers, however, differ among themselves in minor respects with regard to the stage to which they carry certain of the by-products. For example, Armour & Co. produce sandpaper—as a means of utilizing some of the glue manufactured—and numerous chemical preparations, such as pepsin, which are not made by other packers. Again, some of the leading companies make butterine and soap, while others sell the material for these products to outside factories. But, however the leading packing companies may differ in these details, none of them permits anything of material value to be wasted.

A brief description of the more important by-products of beef will facilitate comprehension of the general nature of the packing industry.

The most valuable by-product derived from cattle is the hides, which are worth on the average about $6 per head. A great number of classes and grades of hides are distinguished, which differ considerably in value. The hides are salted and kept by the packers from two to six months, according to the state of the market. During this period the hides shrink in weight, the shrinkage averaging roughly one sixth of the green weight.

Next in importance are the fats obtained from the abdominal region and from other parts of the animal which do not constitute beef. At present the better fats, especially those which may readily be detached by cutting or pulling, are so largely destined for use as a constituent of butterine that they are known as butter fats. An average beef animal will produce from 60 to 75 pounds of such fat. By heating, oleo stock is first derived from these fats. This is nearly the same in constitution as ordinary prime tallow, and if the market for oleo products is much depressed tallow may be produced for sale instead of oleo stock. Otherwise the stock is subjected to powerful pressure, which separates the oleo oil from the

stearin, both of which are standard marketable products. Some of the packers, however, use part of their oleo oil and stearin in manufacturing butterine, lard compounds, and cooking oils.

A moderate quantity of tallow and grease, of several grades, is secured by cooking the heads, feet, and other offal, but the quantity and value of fats of this character are much less than those of butter fats.

The third by-product of a beef animal, in order of importance, is the tongue, which is either sold fresh, or more often is cured or canned. The leading packers ordinarily designate all parts of cattle, except the dressed beef, hides, butter fat, and tongues, by the term offal. Among the various articles constituting offal, the liver, heart, sweetbreads, and tails may be marketed without other treatment than trimming.

The other forms of offal require a much more extensive preparation in order to become satisfactorily marketable. From the heads are cut the cheek meats and other small bits of meat, and sometimes the lips, these meats being usually sent to the sausage department. One or two of the packers use part of the horns and leg bones of the cattle slaughtered in the manufacture of various novelties, otherwise these materials are sold to outside concerns for that purpose. The remainder of the feet, however, with the trimmed heads and various other minor parts and trimmings, are subjected to processes of treatment by means of which tallow, glue, neatsfoot oil, and other minor products are extracted. The residue after such treatment is used for fertilizer. The blood of cattle and various soft parts not containing other valuable material are also converted into fertilizers. The leading packers manufacture a great variety of commercial fertilizers, including those in which phosphates and other mineral substances are combined with the animal products.

The only remaining by-products of any importance are those derived from the intestines, which are carefully cleaned and converted into casings for sausages and other similar products. The weasand, or gullet, and the bladder are also cleaned and made into containers for various commodities, some weasands, for instance, being used for packing snuff.

DAIRYING.

BY HENRY E. ALVORD.

[Henry Elijah Alvord, organized 1895, and since then chief Dairy Division U. S. Department of Agriculture; born Greenfield, Mass., March 11, 1844, educated at Norwich university 1863; entering volunteers as private in 1862, rose to major 2d Mass. cavalry 1865; captain regular army, 1866–72; farmed and taught agriculture in Virginia, New York, Massachusetts, Maryland and New Hampshire; professor agriculture Massachusetts agricultural college, 1887–92; president Association of American agricultural colleges and experiment stations 1894–5. Author: American Chapters of "Dairy Farming" and numerous articles on agriculture.]

One of the most striking features in the history of dairy farming in the United States is the transfer of this productive industry, in large part, from the farm to the factory. The cows and milk continue to be farm property and products, but a constantly increasing share of the labor of converting milk into marketable form is done at creameries, cheese factories, and condenseries. The products of these establishments come into the realm of manufactures.

This change has taken place during the last half century, which covers the period of development of associated and co-operative dairying in America. When the milk produced on two or more farms, or the cream from such milk, is brought together at one place to be condensed, or made into butter or cheese, domestic industry ceases, the place becomes a factory, and its output a manufactured product. The United States census of 1850 noted the existence of 8 cheese factories. The number increased very little until after 1860, but in 1870 there were 1,313 reported, including both cheese factories and butter factories, generally called creameries. The census for 1880 reported 3,932, and that for 1890 gave the number as 4,712. The latter number of establishments represented those only from which reports were received. It is known, however, that a considerable number of such factories, probably 2,500, were then actually in operation from which no returns were obtained for the eleventh census.

The production of butter, cheese, and condensed milk was increased greatly during the last twenty years, the capital having increased from $9,604,803 in 1880 to $36,508,015 in

1900, a gain of $26,903,212, or 280.1 per cent. The products in the same period increased from $25,742,510 to $131,199,277, a gain of $105,456,767, or 409.7 per cent, and the number of establishments increased from 3,932 to 9,355, or 137.9 per cent. (The total of 9,355 is made up of 9,242 regular butter, cheese, and condensed milk factories, and 113 urban establishments reporting the manufacture of butter or cheese or both.)

In order to present the dairy industry of the United States as a whole, there are here brought together certain statistics of agriculture and of manufactures. The totals for the census year 1900, thus combined, are as follows:

Cows kept for milk, on farms, number	17,139,674
Cows kept for milk, not on farms, number	973,033
Total number of cows kept for milk	18,112,707
Milk produced, on farms, gallons	7,266,392,674
Milk produced, not on farms, gallons	462,190,676
Total gallons of milk produced	7,728,583,350
Butter, made on farms, pounds	1,071,745,127
Butter, made in factory creameries, pounds	420,126,546
Butter, made in urban dairy establishments, pounds	827,470
Total pounds of butter made	1,492,699,143
Cheese, made on farms, pounds	16,372,330
Cheese, made in factories, pounds	281,972,324
Cheese, made in urban dairy establishments, pounds	662,164
Total pounds of cheese made	299,006,818
Condensed milk produced, pounds	186,921,787
Value of total butter made, at 18 cents	$268,685,845
Value of total cheese, at 9 cents	26,910,614
Value of total condensed milk	11,888,792
Value of total cream sold	4,435,444
Value of total sundry factory products	1,261,359
Value of total milk consumed	277,645,100
Aggregate value dairy products of United States	$590,827,154

The statement has been frequently made that the associated system of dairying originated in the United States, and it has been called the American system. Those who first associated themselves and brought milk together from different farms for making butter and cheese probably never heard of such methods elsewhere, and were originators for their own time and neighborhoods. But in the Jura mountain region of France and Switzerland, co-operative cheese making has

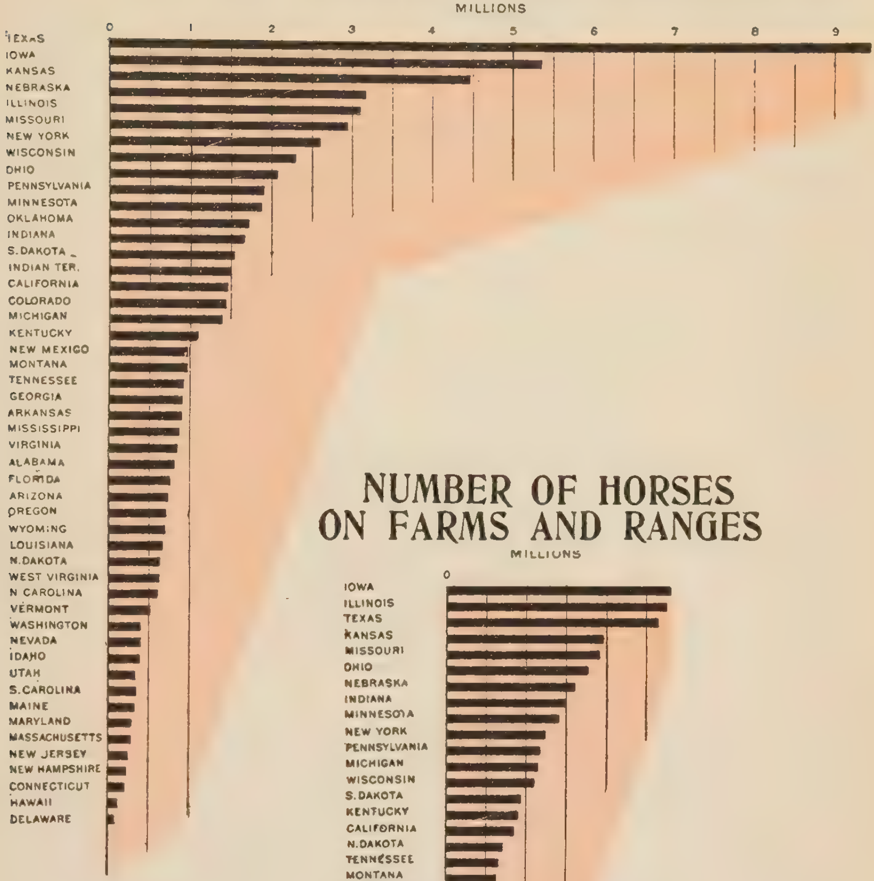
been systematically practiced for at least four centuries, and probably much longer. In the United States, co-operation among dairymen was first applied to making cheese. This plan first attracted attention and was recognized as successful in Oneida county, N. Y., about 1852. Very slowly the cheese factory became an established institution; but once fairly started in the heart of the cheese making district of New York the system spread rapidly. The war period, during which the price of cheese more than doubled, lent additional impetus to the movement. A like effect was produced by the increase in cheese exports which occurred about the same time, These exports rose from 13,020,817 pounds in 1850 to 53,089,468 in 1865.

Cheese factories were started in Pennsylvania and Ohio soon after they became popular in New York, and later they appeared in other states, east and west.

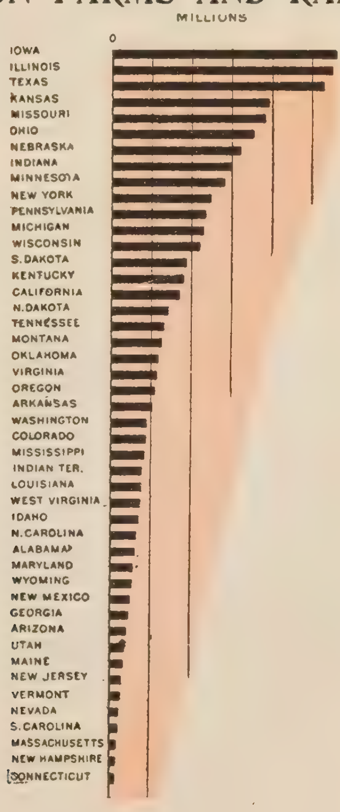
The system of making butter in quantity from milk or cream collected from numerous farms soon followed the introduction of cheese factories. Such establishments are properly butter factories, but the name of creamery has been generally adopted and is not likely to be changed. So far as known, the creamery system of butter making originated in the United States. The first creamery was built in Orange county, N. Y., in the year 1864, and received daily the milk from 375 cows. In Illinois the first cheese factory was started in 1863, and the first creamery in 1867. In Iowa these events took place in 1866 and 1871, respectively.

The early cheese factories and creameries were purely co-operative concerns, and it is in this form that the system has usually extended into new territory, whether for the production of butter or cheese. The cow owners and producers of milk join upon any agreed basis in organizing, building (or renting and refitting), equipping, and managing the factory, and disposing of its products. The farmers interested as joint owners, and all who furnish milk or cream, are called patrons. The operations are managed by a committee or board of directors chosen by and from the patrons. If the business is large enough to warrant the expense, the immediate supervision is intrusted to a single manager, employed

NUMBER OF NEAT CATTLE ON FARMS AND RANGES



NUMBER OF HORSES ON FARMS AND RANGES



by the board. In a factory of this kind all expenses are deducted from the gross receipts and the remainder divided pro rata among the patrons upon the basis of the raw material contributed. Another plan is for the plant to be owned by a joint stock company composed largely, if not wholly, of farmers, material being received from any satisfactory producer. In this case interest on the property or capital is usually included in the current expenses; the management is otherwise the same. The proprietary plan is also common, being conducted much like any other factory. The proprietor, firm, or incorporated company buys the milk or cream of producers at prices mutually agreed upon from time to time, and assumes all the expenses, risks, and profits of the business. Another way is for the factory, however owned, to bear all expenses and charge a fixed price per pound for making and selling the product. The proceeds of sales, less this fixed price, are then divided as on the purely co-operative plan. All of these methods are varied and modified in practice. Settlements are made monthly in almost all cases, and these cash payments to the patrons have a marked effect upon the tone of business in any community where successful factories are operated.

It was impossible to separate these establishments in classes according to all the modifications of ownership and management, but 4 groups were made: Individual, 4,509; firm, 1,340; corporation, 1,628; co-operative, 1,813; total, 9,242. It thus appears that the proprietary plan or private ownership is now greatly in excess of the co-operative system. The tendency has been in this direction for a number of years. In New England, less than twenty years ago, all the creameries were co-operative; now a bare majority remain so in Massachusetts only. In Iowa, where the co-operative plan formerly prevailed, less than one third still remain of that form. Minnesota creameries were for years nearly all co-operative; about 60 per cent continue to be so. As examples of the other extreme, only 7 factories are co-operative out of 178 in California, only 12 out of 171 in Kansas, and but 377 out of 2,018 in Wisconsin.

Although establishments of this kind are usually successful, there is mismanagement and failure, as in other lines of industry. Many have been started by promoters, injudiciously located or overcapitalized, and closed after brief careers. Fires, consolidations, and other changes of ownership add to the causes for frequent changes. Of the 9,242 establishments enumerated in 1900, over one half, or 5,389 were reported as established within the preceding decade, and 828 as started during the census year.

The creamery system was introduced east of the Hudson river about twenty years ago, upon what was known as the cream gathering plan. This was a popular form of creamery management in some western states and in parts of the middle states, from 1876 or 1878 until after 1890. Under this plan the milk was separated by gravity (or "setting") on the producing farms, skimmed there and the cream only went to the creamery, being usually collected daily by agents or gatherers from the factory, hence the name "cream gathering." The dairy centrifuge, or cream separator, made its appearance in America in the year 1879 and has revolutionized dairy and creamery management. The popularity of this machine for mechanical skimming or separation of cream dates from about 1885, and since that time the separator plan has been adopted by practically all new factories, and has rapidly replaced the cream gathering plan in established creameries. The separator, operated by power, has been placed at the creamery, and at its branches or separating stations; and the milk for butter has been hauled daily to these places to be there creamed or separated. This radical change of management accounts for the decrease in cream as a material received by the creameries, and partly for the increased quantity of milk so received.

That cream gathering creameries have not ceased to exist, however, is evident from the quantity of cream still included in the creamery receipts of materials. There were 203,673,958 pounds reported for 1900; of this 63,308,657 pounds (7,720,568 gallons) were sold by the creameries, leaving 140,365,301 pounds, or enough to make 40,000,000 pounds of butter, being almost 10 per cent of the entire creamery out-

put. Iowa is a good example, although not a strong cream gathering state. It is known that 10 per cent of all creameries in Iowa are conducted on the cream gathering plan, and 7 per cent in addition combine this plan with that of receiving whole milk to be separated at the creamery.

The large quantity of cream still appearing as raw material at the creameries is indicative of the change in the system. The centrifugal cream separator was introduced and generally adopted in large sizes requiring steam power, and of such capacity that one machine, operated a few hours every morning, could cream the milk from several hundred cows. One powerful separator is therefore the usual equipment of a creamery, and does the work for a whole neighborhood. It has been found, however, that the labor and expense of daily hauling the entire milk product of patrons' farms to the creamery, often several miles distant, is too great a tax upon the industry. A movement toward relief to the patrons and economy in creamery management has been the establishment of neighborhood skimming stations, equipped only with a separator and power to operate it, as branches of the central plant. From these stations the cream is transported to the parent butter making factory. Centrifugal separators in use by creameries were first enumerated for the census of 1900, also, for the first time, the branch factories or separating or skimming stations. Separators to the number of 9,701 were returned and 2,719 branch stations of all kinds. While cheese factories sometimes have branches of the parent establishment, they do not have separating or skimming stations; all the latter class of subsidiary establishments, and also a part of the other branch factories, may therefore be taken as belonging to creameries. Hence, if to the 5,567 creameries there be added 2,050 skimming stations and 669 other branches, 8,286 establishments are found having use for separators. About 1,600 creameries, therefore, use two or more separators. The exact number which are still operated without the centrifuge, or upon the old cream gathering plan, remains undetermined.

The new elements influencing modification in the creamery system are the invention of what is known as the Babcock

fat test for milk and the adoption of the farm separator in sizes for either hand or power. The Babcock test is a chemico mechanical contrivance, not difficult to operate, by which the percentage of butter fat in either milk or cream may be measured with mathematical accuracy, and the value of the butter making elements thus fixed, so far as quantity is concerned. Accordingly, the milk may be separated on the producing farm by the most convenient process, and only the cream sent to the creamery, where actual butter value is determined by test and the cream paid for accordingly. Milk delivered at creameries and cheese factories is now generally tested in this way, and paid for on the basis of its fat contents or butter making value. The butter fat, as measured by this test, is paid for at a fixed price per pound, irrespective of the weight or bulk of serum with which it is mixed in the form of milk or cream. Farm and creamery methods are so much simplified by these improvements that many dairy farmers are procuring private separators. The state dairy commissioner of Iowa reports 904 farm separators owned by patrons of creameries in 1898, 1,762 in 1899, 3,332 in 1900, and 5,231 in 1901. This new form of the cream gathering plan is rapidly extending. Cream again forms a large share of the raw material received at the factories for butter making, and the next census will probably show, instead of a decrease, a very considerable increase in this item.

The quantity of butter made at creameries has been reported under two heads—packed solid and prints or rolls. It appears that of all creamery butter, 328,956,590 pounds, or 78.3 per cent, is packed in solid form, and 91,169,956 pounds, or 21.7 per cent, in prints or rolls. The totals of these two forms in the several states indicate differences in the market requirements and the local customs as to preparing butter for shipment and sale. In the New England states, the numerious cities and large towns easy of access furnish markets where butter can be sold directly to retail dealers or consumers. For this purpose it is prepared in bricks, prints, or balls weighing a half pound or a pound. Vermont excepted, the creameries of these states make twice as much butter into prints as they pack in solid form. In Rhode Island

and Connecticut, with consuming markets at their doors, 8 pounds of creamery butter is put into prints to every pound packed. In Vermont, on the contrary, with little local demand and the consequent necessity of shipping away to market, only about one fourth of the creamery butter is made into prints. In New York the practice has always been to pack butter solidly in firkins, tubs, or boxes; and print butter is rather exceptional in the great market of New York city. In that state, therefore, $4\frac{1}{2}$ pounds of butter are packed to 1 pound put in prints. The Philadelphia market, on the contrary, and Pennsylvania markets in general, have always been noted for print butter; consequently, it is not surprising to find that the creameries of that state report almost as much made into prints as the quantity solid packed. From Iowa, Wisconsin, and Minnesota butter must be sent long distances to market, and naturally goes mainly in bulk; less than one eighteenth of the creamery product of those states is made into prints. South Dakota, even more remote from market, packs 99 per cent of its creamery butter in solid form. But upon the Pacific coast local customs favor butter rolls of 2 pounds weight; accordingly, in the states of California, Oregon, and Washington, three fourths of all the butter made at creameries is reported as in prints or rolls.

Creameries which are able to market butter in the form of prints or rolls generally derive a benefit therefrom. Although extra labor is required to prepare butter in this way, and packages and transportation for it cost rather more, it is a retail form, attractive, brings a higher price, and can be sold more directly to the consumer, saving the commissions of the middlemen. The average price obtained for all butter, as reported by the creameries for the census year 1900, was very nearly 20.1 cents per pound. The average for that packed solid, for the United States, was 19.4 cents, and for the prints or rolls 22.1 cents. The advantage of nearby markets is shown by these average prices for print butter: Connecticut, 24.6 cents per pound; Massachusetts, 23.5 cents; and Pennsylvania, 23.4 cents. For California creamery rolls the average was 22.3 cents. Contrasted with these is the average price for the packed or tub butter of Iowa, Minne-

sota, and Wisconsin creameries, 19 cents; 18 cents for Nebraska, and 17 cents for Kansas.

Assuming the substantial accuracy of the returns from creameries of milk and cream received for making butter, and of the butter made from it, interesting computations can be made of the ratio of milk to butter in the country at large and the several states. The results illustrate the difference in the average richness of milk in different localities. The nearest quarter pound obtained in each calculation is taken as quite accurate enough for purposes of comparison. It is thus found that creameries of the United States require, on the average, 22½ pounds of milk, or its equivalent in cream, to make 1 pound of merchantable butter. New York appears to have the richest milk of any of the leading dairy states, its creameries making a pound of butter from every 21 pounds of milk received. New Hampshire stands second, with a ratio of 21¼ to 1, and California third, 21½ to 1. Minnesota, Pennsylvania and Wisconsin are alike, showing 22 pounds as the average. Then Illinois, 22¼; Kansas and Vermont, 23¼; and Iowa, 24 pounds. These 10 states suffice for illustration. The results cannot be accepted as absolutely accurate; it is probable that the average pounds of milk stated for the country at large and for most of the states named, is somewhat below the truth. For the United States the ratio stated would indicate that all milk contributed to creameries has an average of 3.8 per cent of butter fat. For New York the average would have to be 4.1 per cent fat. It is not likely that the average richness of milk is as great as this. Nor is it probable that there is so great a difference between New Hampshire and New York, and Vermont, in this respect. The comparison between Minnesota and Wisconsin, Illinois and Iowa, is believed to be correct. Wisconsin has large holdings of special purpose cows, animals giving rich milk, and the same is true of Minnesota to a considerable degree, while in Iowa the general purpose cow is popular, giving milk less in quantity and poorer in butter quality.

If, instead of the above, 23 pounds of milk to a pound of butter is assumed as the average for the United States, this would necessitate milk with an average of 3.7 per cent of

butter fat. No state has dared to fix a legal standard as high as this, and only one has a standard above 3.5 per cent.

The returns of creamery products for 1900 give evidence that the sale of cream has become a large and profitable branch of the business in some states. The creameries of New York, Illinois, and Pennsylvania made sales of cream, respectively, as follows: 1,492,926 gallons at 53 cents, 1,190,125 gallons at 56 cents, and 686,316 gallons at 58 cents. No other state sold as much as a million gallons, but in these 3 the cream sales equalled 8 per cent of the value of butter sold. A different and notable case is that of the state of Maine: its creameries sold 755,845 gallons of cream at 71 cents a gallon, or $534,295, and this was considerably more than half as much as the total butter sales of the state. The quantity of cream reported as sold by all the creameries of the United States was 7,720,569 gallons, valued at $4,435,444, or 57 cents per gallon; the profit of this branch of the business is seen by the fact that, at the average creamery receipts for butter, this quantity of cream, if made into butter, would have realized only $3,438,754. Ordinarily the gallon of cream thus sold would be the equivalent of a fraction less than 2 pounds of butter.

The great amount of 2,253,494,156 pounds of skim milk is reported as sold, fed, or returned to patrons. The total value is given at $2,531,460, or 11.2 cents per 100 pounds. Skim milk is believed to be actually worth twice as much as this to farmers who will use it judiciously as food for young stock. But commercially it is worth less, or about 10 cents per 100 pounds; this is the usual price allowed to patrons who sell it to the creameries for conversion into casein.

A comparatively new branch of the dairy industry, which has acquired importance enough to deserve mention, is the production of commercial casein from the skim milk of creameries. Milk from which all the fat has been extracted by the separator is coagulated by acid, the whey drawn off, the acid washed from the curd, and the curd or casein then dried. The desiccated product has a commercial value of 3 to 5 cents per pound at the creameries where made, depending largely upon subsequent cost of transportation, and is used for making a glue good for paper sizing, as a binder for cheap paint, a

filler for dressing wood and heavy fabrics, and for various other purposes. The statistics of creamery products show 12,298,405 pounds of this material made during the census year 1900, having a value, at the creameries, of $383,581, or only a little more than 3 cents a pound. The state of New York produced more than half the total quantity, and Pennsylvania and Illinois are the only others in which over one million pounds were made.

The management of the cheese factory is in some respects similar to that of the creamery. Patrons deliver the whole milk at the factory daily, while still sweet and sound, and it is made into cheese without delay. Cheese is the only commercial product of the factory, and the only waste product is whey. The latter may be returned to patrons, or fed to swine at the factory, or sold to be used as the material for making sugar-of-milk. For a score of years or more after these factories became numerous they made cheese which, although different in form, size, color, and quantity, was nearly all made upon the same general plan, closely resembling that of the English cheddar. Hence a certain uniformity of type was established which became known as the standard American, or full cream factory cheese, also often called cheddar. During the last ten or twenty years, however, a much greater variety has entered into the factory cheese; this is chiefly the result of imitating certain popular foreign kinds. The twelfth census has, for the first time, attempted to classify the factory product. It appears that the 3,871 cheese factories of the United States reported a total production of 281,972,324 pounds of cheese during the census year, as against 238,035,065 pounds in 1890, and that of the former quantity 225,776,105 pounds was of the American standard factory kind, and 56,196,219 pounds, or 20 per cent, of the several other varieties.

In New York 89.2 per cent of the cheese product was of the standard full cream, cheddar made variety, and this preponderates in Ohio, Michigan, and Pennsylvania. These are the oldest cheese making states. In Wisconsin the 77,748,680 pounds was divided as follows: American standard 62.1 per cent and the other kinds 37.9 per cent. In Illinois, however,

the standard is exceeded in quantity by the other varieties—4,324,461 pounds of the former to 4,730,658 pounds of the latter. These other kinds comprise various well known foreign varieties, those made in large quantity being mainly the Swiss gruyère or emmenthaler and the limburger; there are also some resembling the latter, especially the brick cheese. The Neufchatel and cream cheese, the brie and camembert, are also made in considerable quantities. The value of cheese at the factory is reported as averaging nearly 9.5 cents per pound, being a little more for the standard variety than the average for all other kinds.

The quantity of whey reported as the waste product of cheese factories is 209,067,667 pounds, but this had a value of only $204,277. It appears that of this only 21.3 per cent was sold and the remainder used or returned to the patrons. As milk sugar is the sole commercial product for which whey is utilized in the United States, it is probable that all reported sold was for that purpose. The quantity of sugar-of-milk manufactured was not ascertained. There are only three or four places in the United States where this article is made, and yet it is produced here in greater quantity than anywhere else in the world.

The condensed milk industry was started about the same time as the factory system for making butter and cheese. Some method had long been sought for preserving milk, but none was successful until the invention of Gail Borden. After ten years of experimenting, he decided that a semiliquid state was the best form of preservation, and in 1856 settled upon the process which has since popularized the product in every quarter of the globe. The present extensive industry, in Europe as well as America, with its numerous different establishments and many commercial names or brands, is based upon Mr. Borden's methods. This applies to the unsweetened article as well as that preserved with sugar, for plain condensed milk was first introduced and put upon the market about the year 1861. It was then mainly in open vessels and intended for early use. Between 1860 and 1870 milk in both forms had become well known, and four or five factories were in operation, each producing about 5,000 1-pound cans per day.

It now appears that in the year 1900 there were 50 establishments for condensing milk, operating in 14 different states. The two states of New York and Illinois contain more than half of the condenseries reported, and produce over three fourths of the entire output. Eleven states produced over 1,000,000 pounds of condensed milk each during the census year 1900. Arranged in the order of greatest product, they were (with number of condenseries in each from which statistics were obtained): New York, 16; Illinois, 11; Michigan, 4; California, 2: Wisconsin, 4; Pennsylvania, 3; New Hampshire, 1; Maine, 1; Vermont, 2; Washington, 1, and New Jersey, 1. The number of these establishments, with the position of the state in this list, gives a fair idea of the distribution of the industry. The total product in New York was 75,447,148 pounds, followed closely by Illinois, with 71,257,449. As the latter state has only 11 factories while the former has 16, the size of those in Illinois must be relatively large. Michigan made 18,378,869 pounds of condensed milk, but no other state in the above list made as much as 5,000,000 pounds. Missouri, Indiana, Kansas, and Ohio, with one condensery each, produced from 100,000 to 380,500 pounds.

There are several interesting items in the statistics of this industry. Although a considerable but unknown part of the product is the plain or unsweetened article, the sugar used for the remainder costs more than half as much as all of the milk condensed and preserved. The materials have a total value of $8,907,021, and that of the finished product is $11,922,472 for the whole country. But the cost of manufacture includes, besides the materials, the use and wear and tear of the factories, with their expensive machinery and general equipment, and the wages of many skilled employees. The value of the condensed milk, at the factories, appears to average a little over 6¼ cents per pound, in cans. There is a variation between 6 and 7 cents in different states, which is easily accounted for. In some the proportion of unsweetened milk is much greater and the cost and value correspondingly less. The quality of milk and of condensed product is very much better in some cases than in others, and the consequent

cost and value are more. Under the general designation of condensed milk are included all the preparations of milk from which a large part of the water has been evaporated, including sweetened and unsweetened condensed milk, evaporated milk, condensed cream, and evaporated cream. These names are rather indiscriminately used, as cream or even enriched milk is seldom condensed or evaporated, while it is unfortunately true, on the other hand, that much poor and skimmed milk is condensed without being so marked or named.

The census returns of the prices to patrons for milk are probably not altogether reliable, although they can not be far from the truth. It appears that for the census year 1900 the average price paid to producers delivering milk to butter factories was 77 cents per 100 pounds, while cheese factories paid an average of 78 cents and condensed milk factories \$1.11. According to the returns, the prices for milk for making butter ranged from 64 and 65 cents per 100 pounds, in Kansas, South Dakota, Utah, and Wyoming, and 77 cents (the average) in Illinois and Iowa, to 82 cents in New York, 85 in California, 84 in Oregon, 87 in Washington, 90 in Pennsylvania, 93 in New Hampshire, 95 in Massachusetts, and \$1.08 in Connecticut. For cheese making the factories paid an average of 86 cents per 100 pounds for milk in California, 83 cents in New York, 76 in Michigan, 74 in Wisconsin, and 72 in Ohio. Condenseries are reported as paying 96 cents per 100 pounds for milk in Illinois, \$1.14 in California, \$1.15 in Pennsylvania, and \$1.35 in New York.

Computation of the per capita consumption of dairy products annually in this country is a simple matter so far as butter and cheese are concerned. To the aggregates made on farms and in factories, including urban establishments, as already given, the imports must be added and the foreign and domestic exports deducted. The average of butter imported per annum for the five years reported nearest to the census year was 47,400 pounds, and the corresponding exports, 25,600,000; but for 1900 these quantities were 44,977 pounds (net) and 18,266,371 pounds. Consequently, there was available for consumption in the census year the net quantity

of 1,474,477,749 pounds of butter, which provided a small fraction over 19 pounds for each inhabitant.

Of cheese, the average imports for the same period were 12,400,000 pounds (net) and the exports 46,000,000 pounds. For the year 1900 the exact quantities reported were, respectively, 13,247,714 pounds (net) and 48,419,353 pounds. The quantity available for consumption in the year was, therefore, 263,835,179 pounds, or 3.3 pounds of cheese per capita of the population.

Condensed milk is both exported and imported, but the records are reported by the Treasury department in values only, not in quantities. The best course possible is to value all alike at 8 cents per pound. Upon this estimate, for the census year 1900, the imports of this commodity were equivalent to 533,196 pounds (net) and the exports 14,242,525 pounds, making the quantity available for consumption in the United States 173,212,458 pounds, or at the rate of 2.3 pounds per capita per annum. This result is rather surprising, but may be regarded as approximately correct.

CANE SUGAR.

BY F. G. FRERET.

[F. G. Freret of New Orleans is the most thorough student of the cane sugar industry in the United States; he has had practical experience in all branches of the industry and is an acknowledged expert both in methods of cultivation and of refining; he was placed in charge of the census investigation into this industry in 1900.]

The cane from which the sugar of Louisiana and Hawaii is made is a member of the large family of grasses, and is known botanically as saccharum officinarum. The stalk consists of nodes and internodes, generally of 1 to $1\frac{1}{4}$ inches in diameter. The nodes in well developed cane are from 4 to 6 inches apart, and from the upper side of each springs a clasping leaf, from 3 to 5 feet long, which, as it approaches maturity, recedes from the stalk, and when ripe falls off. The roots of the cane spring from the lower side of the node and are lateral and fibrous, affording but little stability to the stalk in soils wetted by rain. The bud or eye of the cane is found at the base of each internode, and before maturity is protected by the leaf; when fully developed it is about three eighths of an inch long and one fourth of an inch wide, and is the source or parent of the new cane. Toward the top, or immature portion of the stalk, the eye is flat, and, although apparently of imperfect powers of germination, produces a perfect and healthy scion. While stalks of cane are used for planting, being the vehicle by which the eye or bud is preserved, it has been demonstrated that true seed is to be found in the pinnacle of flowers which crown the cane stalk. The flower or arrow of the cane resembles the blossom of the sedge, but is sometimes 30 inches high, dust colored, and charged with innumerable winged seeds, nearly all of which are infertile, owing, in all probability, to the long continued propagation of the plant by means of eyes or cuttings.

There seems to be sufficient evidence to justify the assertion that the sugar cane is a native of southern Asia. The

Chinese claim to have been sugar makers for three thousand years, and while their claim can not be refuted there is no proof that the plant was cultivated in that country as early as in Cochin China and Bengal.

It was at one time supposed that the true seed of the sugar cane was found only in the eastern hemisphere, and that the plant must, therefore, have been of old world origin, but the reasoning was based upon a wrong premise, as cane now produces fertile seed in both hemispheres. After the crusades the cultivation of cane extended from Asia into Africa and to the islands of the Mediterranean. The Portuguese carried sugar cane to Madeira and the Canaries, and Europe received its supply of sugar for many years from these islands.

Columbus on his second voyage carried this plant to new fields of usefulness, when he introduced it into the islands of the Caribbean sea and Gulf of Mexico. From these islands its course to the Spanish main and Mexico was speedy, and before the close of the century sugar cane was cultivated in all tropical America. Although there is no evidence of the passage of the sugar cane from either shore of the Pacific to the islands of that ocean, we have the testimony of the earliest European visitors that the plant was found growing luxuriantly on the islands of the mid-Pacific.

As early as 1751 the Jesuit fathers brought to Louisiana samples of sugar cane for the purpose of adding to the resources of the colony. The canes introduced were of the Bourbon or Malabar variety, now known in Louisiana as Creole cane. The original consignments were of small quantities, and were sent as a present by the priests in Hispanola to those of their order in New Orleans, but the small beginning of the Jesuits soon furnished seed cane for a number of fathers living in the neighborhood. At first the prices obtained for the cane stalks precluded the idea of the establishment of works for the extraction of the juice on a sufficiently large scale to justify the expense of machinery for crushing and boiling.

The first sugarhouse equipped with machinery to crush the cane and evaporate the juice was erected by Dutreuil in

1759. The experiment resulted in failure. By degrees, however, mechanics were brought from Santo Domingo and Cuba, sugarhouses were built, and for years the pioneers in the industry struggled with apparently insurmountable difficulties. The sirup would not grain, and instead of the bright yellow crystals, such as were produced in the islands, only a sirupy mass remained as a reward for their labor and expense. Some of the more enterprising planters set up dunder tubs and stills, and converted the sweet juice into what they called tafia, a species of fiery rum, which soon spread its baneful influence among the negroes and Indians of the colony.

After a few years the Spanish governors issued edicts restraining the production of tafia, and, by the time the first legislature of the territory was convened, the manufacture of the distillate had almost ceased. The years passed, and still the manufacture of sugar seemed unattainable, although every effort was made by the farmers and their employees to bring about the desired results. Early in the last decade of the eighteenth century, although the newly imported Otahaiti cane was brought from Cuba, where it had been introduced as one of the results of the heroic Bligh's efforts, the sugar cane of Louisiana growth was not sufficiently matured to produce crystallizable juice, and the planting world was casting about for some staple to take the place of the cane, from which so much had been expected.

In 1795, Etienne De Boré announced that he had discovered the process necessary to obtain grained sugar. When the spring of 1796 opened, the area and condition of the cane crop on Sieur De Boré's plantation was the wonder of the neighborhood. When the crop was ready for the mill, the juice was extracted by means of simple crushing machinery, operated by horsepower. The juice obtained was conducted into storage boxes, and thence to a series of kettles for evaporation. The process of sugar boiling was kept up continuously, the sirup being bailed forward from one kettle to another until it was reduced by evaporation to liquid sugar and was ready to be passed from the last kettle to the coolers, after which it was spread out on the floor of the sugarhouse.

The essential change introduced by Sieur De Boré was probably the use of lime or alkali in some form for the purpose of neutralizing the free acids found in cane juice, thus materially assisting the process of granulation. The sugar makers of the West Indies used alkali for this purpose, but endeavored to carefully guard the process. After its introduction into Louisiana the early sugar makers were eager to keep secret the results of their individual experiments in the determination of the proper amount of alkali to be used. This quantity varies with the character of the season in which the cane is grown. In very dry seasons but little alkali is required, while in wet seasons larger quantities are necessary to induce complete granulation. De Boré's success in making sugar on a commercial scale gave new life to the cane producing industry, and many plantations were soon established.

The first steam driven mill for crushing cane was erected in 1821. The mill turned by this engine was possibly not more than 36 inches long and 24 inches in diameter, and consisted of three rollers so arranged that two rollers were hung in the side supports or housings at a distance of about 8 inches apart, while the third or top roller, the position of which was regulated by bolts passing down through the housings, was so placed that there might be about three sixteenths of an inch between the front and top rollers, and with the back and top rollers touching each other. The stalks of cane were introduced between the first and second rolls, and then by a simple device the half crushed stalks were curved back to the opening between the middle and third rollers and subjected to a second pressure, which extracted a large part of the juice.

The juice after leaving the receptacle below the rollers was run through troughs to boxes, where it was stored until needed to replenish the juice in the first kettle.

In the early manufacture of sugar in Louisiana, four evaporation kettles were commonly used, but the advantages of a new system of five kettles, called the Jamaica train, were so apparent that this arrangement was adopted and in general use until 1840. The kettles were approximately hemispherical in shape, generally of wrought iron, with a wide lip or edge by which they were suspended to the canal.

The canal was the horizontal flue which ran from the furnace to the chimney, so fashioned as to allow the heat from the wood fires to present itself successively to the kettles hung along its course.

The first kettle, which hung directly over the fire, was known as the batterie, the other four, in their order, being the sirop, propre, flambeau, and grande.

In the later years of the open kettle train there were generally two grandes placed across the line of the four other kettles and so arranged that the draft to the chimney passed beneath each of them. In these kettles the entire process of clarification, evaporation, and, in the early years of the industry, the concentration of juice into sugar, was carried on.

Between 1830 and 1840 an improvement upon this method was adopted in some of the larger sugarhouses whereby the kettles were used to transform the juice into sirup, while a separate steam heated pan or kettle was used to concentrate the sirup into sugar. In France, as late as 1827, the chaudière à bascule, or upsetting kettle, was used over an open fire in the manufacture of beet root sugar. This apparatus was tried in Louisiana, but never came into general use.

In 1830, Mr. Thomas Morgan, who is entitled to the honor of being the pioneer in the use of the vacuum pan, erected one of these appliances in his sugarhouse. In 1834 Mr. Valcour Aimé, one of Louisiana's progressive planters, established a Howard vacuum pan in his sugarhouse in St. James parish. He also introduced the use of boneblack as a means of clarifying the sirup, and succeeded in producing a nearly chemically pure white sugar, which he shaped into loaves by the use of molds.

The most important improvement, however, in the methods for converting the juice of the cane into sirup was the invention of Mr. Norbert Rillieux, a native of Louisiana, who conceived the idea that the hot vapor arising from a vessel of boiling cane juice could be used to evaporate the water contained in a second vessel of cane juice. He soon realized that this method could only be made practicable by securing a diminished atmospheric pressure on the surface of

the vessel whose contents it was sought to evaporate by the heat arising from the vapor of a previously and more intensely heated fluid.

An apparatus embodying Rillieux's ideas was erected in December, 1845, on a plantation in Plaquemines parish, La. Although it did not at first prove to be the success which had been anticipated, the results were sufficiently promising to bring about a determination to realize, during the next season, all the merits which the inventor and manufacturers claimed for it. The tests made in 1846 proved successful, and laid the foundation for the elaborate system of evaporation now in use wherever capital and intelligence have combined for the making of sugar.

The value of the machinery and appliances used in an early sugarhouse employing steam power in Louisiana was possibly $7,000 or $8,000, while the output in such an establishment was about 200 tons of coarse brown muscovado sugar for a season's run of four months.

The modern sugarhouse, equipped with engines, double mills, crusher, and all the latest improved clarifying, evaporating, and concentrating apparatus, is erected at an expense exclusive of the cost of buildings, of about $250 for each ton of cane which can be passed through the mills in a day; in other words, the cost of the machinery of a Louisiana sugarhouse competent to crush 1,000 tons in twenty four hours is about $250,000.

The early steam sugarhouses produced a quantity of sugar equal in weight to about 2½ per cent of the weight of the cane milled, a ton of cane yielding about 50 pounds of moist sugar. The sugarhouse of the present day averages about 8 per cent, or 160 pounds of sugar to the ton of cane.

In the early days of the industry the only fuel used was wood, of which from three to five cords were consumed in producing 1,000 pounds of moist sugar; to-day 800 pounds of coal are required for an output of 1,000 pounds of fine yellow or white crystallized sugar fit for immediate consumption.

Until 1860 the growth of the sugar industry in Louisiana was slow compared with the rapid strides made by other agricultural operations in the country.

In the five years immediately preceding the civil war the entire consumption of sugar in the United States averaged about twice the product of Louisiana. To-day, while the output of Louisiana sugar is about 310,000 tons per annum, the consumption of the country aggregates more than 2,300,000 tons.

The cane growing portion of Louisiana is very flat, the slope of the land averaging less than 4 feet, and in many thousands of acres not more than 2 feet, to the mile. In the preparation of land for the cultivation of sugar cane, the ground is usually broken in the fall into lands or beds, from $5\frac{1}{2}$ to $6\frac{1}{2}$ feet wide, a deep water furrow being left between to serve as a drain for the outflow of water after the winter rains. The necessity of great care being observed in the matter of drainage is apparent when it is known that the average annual rainfall is about 50 inches.

Most of the soils of the sugar belt of Louisiana are mixed clay and silt, as the greater part of the land is pure alluvium deposited by the waters of the various streams. The land, which, as a rule, is higher on the bank of the river or bayou, falls away for some distance from the water course, and in consequence, during the period of an overflow, the heavier and coarser sand is first deposited and the lighter particles of sand and silt find their resting places in spots where the current grows sluggish; hence the sandy land is located near the river or bayou and the stiff, clayey lands farther away.

With a heavy rainfall and a retentive soil the necessity for drainage becomes paramount, and the importance of the subject may be appreciated when it is understood that from 15 to 20 per cent of the cost of field labor expended on a well managed crop is for drainage. Occasionally, after severe storms, large portions of the best plantations will be covered with water for days, owing to the inadequacy of the drainage equipment. One such rain storm at a critical time may diminish the size and yield of the cane 25 per cent.

Tile drainage has been tried in the cane fields of Louisiana with but poor results, owing to the fact that the success of this method depends upon a constantly free exit of the water which the tiles have collected. In almost every instance of

tile drainage in lower Louisiana the tiles have accumulated silt, owing to the sluggishness of the current brought about by the slow discharge of the recipient canals.

Planting consists in laying stalks of sugar cane in prepared furrows which run across the field at intervals of from 5 to 7 feet, and in covering the seed cuttings to a depth of from 3 to 6 inches with well pulverized earth. After the earth on top of the seed has been well packed by heavy field rollers, there is nothing further to be done except in the way of cultivation and drainage. Planting is usually done in the spring, although in southern Louisiana it can be done satisfactorily in September, and even through the fall and winter until the end of March.

Putting up seed is generally commenced about the middle of October. The cane is cut at the ground level and two rows of stalks are thrown into a furrow, the leaves being so distributed as to cover the stalks. The cane furrow is then covered with earth, which is rolled until it is smooth and compact, after which the safety of the seed depends upon thorough drainage.

Planting, as has been stated, may begin as early as September and is usually completed by the early days of March. The crop which springs from this planting is called "plant cane," and is cut for the mill in November and December. The stumps or rattoons left in the ground will produce the following year about 75 per cent as much cane as the initial crop of plant cane.

Sugar cane is a tropical plant, and must be harvested before cold weather has ruined its essential properties, and the seed cane must be protected from injury during the cold and rainy season. The varieties of cane first planted in Louisiana—the Creole, or Bourbon, and the Otahaiti—were so sensitive to climatic conditions that their cultivation in that state was found to be impracticable.

Mr. John J. Coiron, while on a visit to St. Simon island, off the coast of Georgia, observed the luxuriant growth of a purple and yellow striped variety of cane, which in 1814 was brought into Georgia from the island of St. Eustatius, to which it had been imported from Java. This fortunate visit of Mr.

Coiron resulted in a determination to procure specimens of the striped cane for his plantation at St. Sophie, a few miles from New Orleans. In 1821 Mr. Coiron secured these samples and the results of his experiments were so satisfactory that in 1825 he imported a quantity of seed plants. From that date the cultivation of sugar cane was placed upon an assured footing.

After Mr. Coiron had shown the value of the newly imported cane, the search for new varieties became constant, several being introduced from Monterey, Mexico, soon after the war. These canes, of a purple variety, supposed to be the black Java, have developed a degree of hardiness which fits them admirably for cultivation in latitudes several degrees colder than the tropics, and several parishes in the more northern portion of the cane belt of Louisiana have become large producers of sugar through their cultivation.

As a result of the disastrous effects of the civil war, Louisiana's sugar crop fell from more than 100,000 tons to 5,331 tons in 1864. Owing, however, to the very high prices which prevailed during the latter part of the war, and immediately thereafter, the prospects of great profits induced the Louisiana landowner to make great efforts to restock his plantation with animals and implements, and as a result of this impetus the industry soon revived and the search for better varieties of cane was again instituted.

In 1872 Mr. P. M. La Price went to the eastern hemisphere, seeking a variety of cane which might be acclimated to Louisiana. After a long and difficult search he returned, bringing valuable greenish yellow cane, which not only stands the rigors of Louisiana winters, but also produces a large per cent of high grade sugar and sirup. In 1877 Mr. Le Duc, then the commissioner of agriculture, introduced the Zevinga, a Japanese variety, and in 1886 the experiment station introduced over 75 varieties.

At the present time the only canes of approved and reliable qualities for cultivation in Louisiana are the purple and the ribbon (black Java and striped Java), and the green cane introduced by Mr. La Price, but great hopes are being built upon the success of the Demarara seedlings, Nos.

74 and 95. The tests in the parish of St. James, made by Mr. H. Tremoulet, of No. 95, a red cane, and No. 74, a green cane, have met with most encouraging results, but a succession of crops and a variety of winter weather will be necessary before a definite opinion as to their availability can be formed. If these canes prove of permanent value, it will be due to the intelligent and persistent exertions of the English botanists and agricultural chemists of Demarara and the adjacent islands. Animated by the same spirit which prompted the French and German beet root chemists and field workers, and believing that their methods were correct and that nothing in the way of improvement was to be expected from the continued propagation of cane from the eyes of a parent cane, they determined to discover the unknown germinative powers of the so-called seed. With restricted means, and aided solely by the climate and soil of the tropics, they commenced their labors which were to result in a demonstration of the fertility of the cane seed and the propagation of the new varieties.

Experiments have been carried on at the agricultural station at Audubon Park, New Orleans, and it has been shown that for every 2,000 pounds of stalks of purple cane, the roots, leaves, and tops furnish 1,511 pounds of matter which is very much in the way of the next season's cultivation; the striped cane, however, furnishes only about 1,154 pounds of such waste to every 2,000 pounds of stalks.

While mention has been made of the roller mill as the most common form of machinery used for the extraction of the cane juice, it must not be concluded that this is the only form of apparatus which has been used for the purpose.

In 1876 an attempt was made to introduce the diffusion process for the manufacture of cane sugar. The machinery was brought from Germany and was not adapted to the work demanded of it, but the experiment served to illustrate the mechanical differences in the manufacture of sugar from sugar cane and from beet roots. Within a few years, however, the diffusion idea gained such popularity in the planting community that 11 complete diffusion houses were established. At present there are not more than three or four in working condition; the process having become unpopular owing to the

fact that the chips were difficult to remove because of their great weight; moreover, the loss of the bagasse as a fuel element was hardly counterbalanced by the increased yield of sugar.

At this time there is discussion as to the value of the chips or bagasse as a raw material for the production of paper stock. If the use of oil deprives bagasse of its relative value as fuel, and the new machinery converts bagasse into paper stock at no greater cost than is now contemplated, it is possible that diffusion batteries may be the prominent feature of the future.

While the improvements in the culture of sugar cane since 1860 have been most important, the machinery now in use, although still based on the same general line as that of forty years ago, is so much more efficient in its general characteristics as to strength and size as to render comparisons almost ridiculous.

One of the most noticeable changes in the management of sugar estates is the growing tendency to buy everything used on the plantation. In the earlier days of this industry but few articles were purchased. Aside from iron for kettles and sundry forge purposes, almost everything was homemade.

The manufacture of sugar to-day is unattended by many of the accessories which formerly made the rolling season the merriest part of the year. The work was hard and incessant, each able bodied man on the plantation, free or bond, being expected to bear his part for eighteen hours out of the twenty four; the fires under the steam boilers and kettles were continuous from midnight on Sunday until midnight on Saturday; every muscle was urged to its utmost, and yet every one on the plantation was glad when the sugarhouse was opened and the tall chimney smoked.

The preliminary step toward sugar making was the cutting and hauling of the cane for a couple of days before the fires were lighted. When the cutting began each worker took a row and began to shear away the leaves which still adhered to the stalks of cane, and with one deft blow cut off the top at the last red joint. The cutter then severed the cane at the earth level and threw the stalk on the heap row at

his side; after which the loaders and teamsters lifted the cane from the heap row into the wagon or cart.

This forced activity was chiefly due to the scarcity of labor. During the rolling season the average wage of 75 cents per diem during the planting and cultivating season rose to a dollar with rations, or a dollar and a quarter without. The primitive machinery which formerly struggled for three or four months with a crop has been supplanted by a complicated and powerful apparatus which in sixty days reduces twice as much cane as formerly came to the sugarhouse. In 1850, 1,490 sugarhouses were required to handle a crop of less than 154,000 tons; in 1900, 281 sugarhouses made over 325,000 tons of sugar.

In the well appointed sugarhouse of to-day, the most important and expensive machinery consists of the double or triple mill and engine. A crusher to prepare the cane for the mill, driven by a separate engine, completes the milling apparatus. From the mill the juice flows to the sulphur machine, where sulphurous gas is injected into the sticky stream for the purpose of bleaching and rendering it antiseptic.

In the tropics cane juice begins to turn acid in less than thirty minutes after it leaves the mill. The antiseptic properties of sulphurous gas are of value even in Louisiana, where decomposition is less rapid.

From the sulphur machine the juice passes to the clarifiers or defecators, where, under a gentle heat and lime, the grosser and insoluble impurities are separated. Thence it goes to the double or triple effects, where the clear juice is boiled at a reduced temperature, consequent upon a reduced atmospheric pressure, until it becomes sirup. As soon as settled and cooled, it is transferred to the vacuum strike pan, where the process of sugar boiling continues until the operator determines that he has extracted from the sirup the largest quantity of crystals of first jet that it is capable of rendering.

To the mixer, a semicylindrical vessel large enough to hold the contents of the vacuum pan, in which moving arms or paddles mix the contents constantly, is the next step in the process; thence to the centrifugal machines, from which the sugar is delivered ready for immediate consumption. The

centrifugal machine consists of a vertical shaft making about 1,200 revolutions per minute, provided at its lower extremity with a metallic basket, in which the sugar and molasses, or masse-cuite, coming from the mixer is washed with water during its rapid revolutions until, by centrifugal force, the sugar is freed from the molasses, which escapes through the fine woven wire that forms that part of the basket.

The molasses flies from the periphery of the basket in the outer casing and goes to tanks, where a sufficient quantity is collected to enable the sugar maker to boil a strike of second sugar. Second sugar, the result of the boiling of the molasses which escapes from the first sugar, requires several days for granulation, but after passing through the mixer and centrifugals a fair article of sugar results, somewhat similar to the muscovado made in the West Indies and in Louisiana fifty years ago.

Up to 1860 almost every sugarhouse equipped with a vacuum pan was fitted to use boneblack as a clarifying or refining agent, an article no longer used in the state. The use of sulphurous gas has enabled a reasonably white or choice yellow sugar to be made directly from the cane, a thing the pioneers in the industry thought impossible.

In the antebellum days the universal custom was for each planter to make the sugar from his own cane. The business was profitable, and the purchasing of cane by one planter from another was unknown.

During the war many sugarhouses were more or less damaged, and at its close the average planter was without means to grow cane or to reduce it to sugar. The plan was devised of making a partial separation of the industry, by which a few planters or central factories should reduce to sugar the cane grown by a much larger number of planters. The introduction of such a system involved many difficulties, owing to the varying percentages of sugar content in cane grown on different plantations or in different years. The first arrangement between cane growers and mill operators was to allow the cane grower one half the sugar made from his crop. Later a system of purchasing cane was arranged which supplanted this share system of reduction, the cane

grower being paid, for cane delivered, a sliding scale of prices per ton, which varied with the price of prime yellow clarified sugar in New Orleans. The usual price for a ton of cane is 80 pounds of such sugar—one half the probable yield of that quantity of cane.

It is considered essential that there should be a full average rainfall, properly distributed throughout the year, to produce liberal crops of cane; but as the records show a range from 36.5 inches to 83 inches, the climatic variations are, in reality, very great, and without facilities for irrigation, during abnormally hot and dry springs and summers, there must be, necessarily, a wide range in the quantities of cane produced per acre.

At one time it was supposed that the nygrometric condition of the atmosphere was an important factor in the growth and richness of the cane; and although its importance has deteriorated in the eyes of the skilled agricultural chemist, there is doubtless more in the theory of the virtues of saturated atmosphere than is at present believed.

One of the most noticeable differences between the cultivation of cane in Louisiana and in the tropics is in the cost of the seed cane as used in the island of Cuba, for example, and in Louisiana. If we take for granted that the thinnest planting or seeding likely to be successful in Louisiana is two canes and a lap, which means that two canes are laid side by side in the furrow with a slight doubling at the ends, then not less than from four to six tons of cane (all of which is fit for the sugarhouse) are necessary to plant an acre; and this means an average value of about $16. In the tropics, however, conditions are entirely different. Intelligent observers from Cuba describe the process of planting in almost the same terms as did Mr. Bryan Edwards, who wrote at the end of the eighteenth century. In his history of the West Indies we have a neat picture of how the tops of the canes that have been cut off as unfit for sugar making are dropped into holes about 18 inches square dug out with a hoe, at intervals of from 4 to 6 feet.

The only expense in planting in the tropics is for labor, the material used for seed being of no value. In fact, methods

employed in some parts of Cuba are very primitive. Rather than give one plowing to land that has been in cultivation for ten years the planter selects a new area, cuts away the underbrush, and girdles the trees, and by the help of fire gets a clean surface and plants it in cane, not cultivating the land on which the stubble is beginning to fall to 12 tons to the acre, alleging that the taking in of new lands is less expensive than plowing the land that has been ten years in cane.

Some of the plantations in Louisiana have been in cane about one hundred years, and the soil is still considered worthy an expenditure of from \$6 to \$8 per acre for commercial fertilizer when called upon for a plant cane crop, and \$4 to \$6 per acre for rattoons.

In Cuba there are many planters who have no plows, their only implements being hoes for digging cane holes and machetes for cutting cane for the mill. In Louisiana a pair of mules, costing from \$300 to \$400, is necessary to cultivate something less than 25 acres in cane. In Cuba, where little plowing is done and draft animals are used only to haul cane to the sugarhouse, two yokes of oxen, worth \$40 a yoke, answer the purpose to the entire satisfaction of the planter.

In Louisiana the sucrose content of cane is rarely higher than 14 per cent, usually not more than 12 per cent, which allows about 8 per cent of commercial sugar to the ton of cane. In Cuba the sucrose content is often as high as 18 per cent, and 12 per cent of commercial sugar is the general output. The yield of cane in Louisiana is about 18 tons per acre for plant cane and 14 tons for stubble. In Cuba new land is expected to produce from 35 to 50 tons. In Louisiana the seed cane often rots either before or after planting, but in Cuba this never occurs, and while the seed cane in Louisiana can not be replaced in the same season, seed for planting is always available in the tropics, and land lying idle for want of sound seed is unknown.

As shown by abundant evidence, sugar can be produced in Cuba for one and a half cents per pound; but in Louisiana, even on a particularly fine plantation and under the best management, the cost of sugar is not less than three cents per pound.

The following figures present a summary of the present position of the sugar industry in its relation to the other branches of agriculture in Louisiana. The statement of acres of farm land, number of farms, and value of farms is for June 1, 1900, while that for crops and products is for the preceding year. A few figures are also given for the crop year 1898.

The total number of farms, June 1, 1900, was 115,969, of which the number raising cane for sugar and sirup making was 13,881, or 12 per cent; of the latter the number raising sugar cane was 11,774, or 84.8 per cent, and the number raising sorghum cane 2,107, or 15.2 per cent. In addition, there were 11 large plantations and a number of smaller ones growing cane for seed, but making no sugar nor sirup, and selling no cane.

The area of land in all crops in 1899 was 3,421,751 acres, of which 277,903 acres, or 8.1 per cent, were used for growing sugar cane and sorghum cane; of this area 276,966 acres, or 99.7 per cent, were devoted to growing sugar cane, and the remaining 937 acres, or 0.3 per cent, to growing sorghum cane. Of land devoted to crops other than cane for making sugar, there were used for cotton, 1,376,254 acres, or 40.2 per cent; for corn, 1,343,756 acres, or 39.3 per cent, and for all other crops, 423,838 acres, or 12.4 per cent.

The total quantity of cane made into sugar, molasses, and sirup, was 2,123,354 tons. The number of tons of cane converted into sugar which were grown by manufacturers on their own lands by labor hired by themselves was 1,072,468; the number of tons grown by tenants and purchased by the manufacturers was 314,461; and the number purchased from others by manufacturers and the eight central factories was 736,425.

In 1898, the 351 central factories and large plantations handled 4,677,174 tons; 2,844,321 tons, or 60.8 per cent, were grown by owners of sugarhouses; 350,699 tons, or 7.5 per cent, were grown by tenants; 1,482,154 tons, or 31.7 per cent, were purchased from others. No tabulation was made of the relative amount of cane converted into sirup in 1899, or 1898. In 1899, cane was grown for sugar or for seed by 320 plantations. Total quantity of sugar, 319,166,396 pounds ($13,099,-

559); total quantity of sirup, 2,480,856 gallons ($564,842); in addition sirup subsequently made into sugar, 923,466 gallons ($157,391); total quantity of molasses, 11,703,877 gallons ($1,277,384). Of the total amount of sugar produced 8,874,929 pounds were made by old processes, and 310,291,467 pounds by modern processes; of new process sugar, 251,789,270 pounds were first, 47,984,887 pounds, seconds, and 10,517,310 pounds, thirds.

In the crop year 1898, there was produced on the large plantations and in the central refineries from cane grown and purchased: Sugar, 556,994,942 pounds ($22,197,168); molasses, 24,164,689 gallons ($1,661,897); sirup, 2,774,961 gallons ($432,481).

Sugar made by modern processes comprised: Firsts, 437,370,968 pounds; seconds, 87,523,291 pounds; thirds, 14,196,078 pounds; by the open kettle process, 17,904,605 pounds.

The 3,870 plantations and farms making sugar industry their principal source of revenue in Louisiana constituted only 3.3 per cent of the total number, and had an area of 1,209,837 acres, or 10.9 per cent of all farm area.

The value of land and improvements, exclusive of buildings, was $33,063,960; value of buildings, $11,027,060; value of implements and machinery, including apparatus for making sugar, and railroads for handling cane, $21,591,940; value of live stock, $4,747,109; making a total fixed capital of $70,430,069, or 35.5 per cent of all the fixed capital in Louisiana agriculture.

In the 79,468 cotton farms the investment was $67,505,143, and in the 32,631 other farms it was $60,601,694. The sugar farms constituted 3.3 per cent, with a fixed capital of 35.5 per cent, while the cotton farms constituted 68.5 per cent, with a fixed capital of 34.0 per cent. The other farms constituted 28.2 per cent, with a fixed capital of 30.5 per cent.

Including what was fed to stock, sugar farms produced $18,019,470, cotton farms $36,823,212, and all other farms $17,824,620. The value of products not fed, or gross farm income, was as follows: For sugar farms, $16,656,300; for cotton farms, $33,523,192; and for all other farms, $15,959,340.

The ratio of income to total fixed capital for sugar farms was 23.6 per cent, for cotton 49.7, and for all others 26.3.

The expenditures for labor and fertilizers on the 3,870 farms making sugar their chief source of income were $6,931,-470 and $709,970, respectively, the total constituting 45.9 per cent of the gross income of the farms.

The 320 plantations in Louisiana that grew cane extensively in the year 1899 reported the following expenses: For labor and salaries, $4,194,862; fertilizers, $468,589; feed purchased, $481,502; labor on plantation railroads and maintenance thereof, $116,276; making a total of $5,261,229, or an average of $4.37 per ton. The average contract price at which cane was bought was $3.56, showing a loss of 81 cents per ton in the field operations.

The average cost per ton of handling 2,123,354 tons converted into sugar in 1899 was $1.60. The value per ton of cane converted in 1898 was $5.19 and in 1899, $7.11, showing a small margin of profit for the sugarhouse operations of 1898, and a large profit in 1899.

THE BEET SUGAR INDUSTRY OF THE UNITED STATES.

BY CHARLES F. SAYLOR.

[Charles F. Saylor, horticulturalist, is the beet sugar expert of the agricultural department of the United States. In this capacity he has made exhaustive investigations into the history and possibilities of the sugar beet and has been largely instrumental in the introduction of it in many localities.]

The production of sugar beets and of beet sugar in the United States is now assuming such proportions that, with the increase of factories and the marked popular interest, it has become one of the leading subjects demanding consideration from agriculturists. There is probably no other industry in this country that has developed so rapidly and now absorbs so large a share of public attention as that of beet sugar.

Attempts were made to establish the beet sugar industry in Massachusetts some sixty two years ago. There were also efforts in this direction in Illinois, Wisconsin, and California between the years 1863 and 1876, and much was claimed for the industry at this time. In California, after a long period of unprofitable production, the industry achieved its first success. The failure of these early attempts seems natural as we look back over the history of agricultural progress in the United States. The beet sugar industry belongs to the domain of agriculture, and the problems it presents are agricultural. These early efforts were simply ahead of their time in the course of agricultural development, and they failed in the establishment of the beet sugar industry for want of the proper methods of farming and the proper conditions underlying the farming industry.

At the time of the first attempts at sugar beet production agriculture comprehended simply the primary features. Its products were confined to cereals, forage crops, and live stock, and the production and marketing of raw materials was its main object. The farmer in those days did not concern him-

self with enterprises dependent on the concentration of efforts in the production of finished products. Land could be purchased for a few dollars per acre. If the prospective farmer did not have the money to buy land he could enter a claim on government land. His whole ambition was to produce something quickly and pay for the lands and primary improvements. This was accomplished by raising corn, wheat, oats, cattle, and hogs. The open public domain offered a free pasture. Gradually the eastern sections became more densely settled, and farm lands became more expensive. Crude production was accomplished more cheaply by the western farmer. Later, owing to development of transportation facilities, the agriculture of this country had to compete with the cheap labor of Europe. The colonial extension of European countries brought areas into competition with American farms in turning out crude products, and with labor much cheaper even than that of Europe. The problem became, how to turn crude material into something that would represent not merely labor but the skill and ingenuity of the American people, thus supplying our own markets and those of the world with finished products. The American farmers found, as the manufacturers had found before them, that their success depended upon the superior skill and artisan ability of Americans as compared with Europeans and their colonists. Necessity is the mother of invention, and demand and necessity united in the evolution of a new system. This began in the east, working westward, in the production of butter, cheese, prepared meats, flour, eggs, poultry, etc. Later came the establishment of other industries, working up crude products of the farm into finished articles. We became producers of sirups, canned vegetables, canned fruits, etc., until manufacturing re-enforced farming from ocean to ocean. When all this was accomplished the time was ripe for the success of the beet sugar industry.

It is one of the marked features of American industrial life that the people as a mass have always shown a readiness to forego immediate benefits and, even at considerable expense to themselves, to encourage industrial development. As a result,this country has made a record among the nations

of the earth unparalleled in rapid development, accumulation of wealth, and hold on the trade of the world. One of the chief items of cost in the production of anything is labor. In this country it is contended that the laborer is not only entitled to earn a living, but to live comfortably, to be able to educate his family, and to acquire a comfortable home. There is no position in life, social, financial, or political, to which the laboring man may not aspire. While this means much for the citizen, it adds materially to the cost of production. This country to-day is the concern of the nations of the earth in being able to maintain a balance of trade in its favor through its agricultural and industrial productions, and this balance is constantly increasing. The sugar industry is supported by American enterprise and spirit, and under this American policy it is rapidly assuming a prominent position in the long list of successful industries.

At certain stages of their growth sugar beets require a considerable amount of labor. This labor is very tiresome. As a rule, the farmer, if he grows beets to any extent, does not have on his farm sufficient labor to do the work of thinning and bunching, hoeing, and harvesting the sugar beets; nor does any farming community possess to any considerable extent the labor necessary to grow the beets that a factory will require. It will cost about $30 an acre in sections where sugar beets are grown under rainy conditions, and about $40 to $45 an acre in sections where beets are grown by irrigation, to cover the cost of seed, preparation of seed bed, bunching and thinning, hoeing, cultivating, harvesting, and delivering to the factory. These estimates apply to growing sugar beets when it is properly done. In the farming communities of foreign countries, as a rule, a large amount of suitable labor can be secured in the neighborhood, because these neighborhoods are more thickly settled; the whole population is willing to do the laborious, tedious work required, and whole families work at it, including the father, mother, and children. In this country, as a rule, the farmer, his older sons, and hired hands must attend to the outdoor work. It has been found necessary for sugar beet growers to resort to the cities and towns for the extra labor required.

Most of this work comes about the time the public schools are closed, and boys from 12 years up are employed for bunching and thinning the beets, for hoeing them during the season, and to aid in the harvesting by pulling, cleaving the tops, and loading the beets into wagons. In the cities also live many foreigners from Holland, Russia, and other places who are thoroughly familiar with this kind of work. These people are willing to move out into the fields and live in tents; they make contracts at so much per acre for bunching and thinning, hoeing, weeding, and harvesting. Since the agitation and starting of the beet sugar industry in this country foreigners are coming here with a view to securing employment of this kind. While the labor question is a serious one, it is one capable of solution by careful and detailed attention.

The estimated production of beet sugar in the United States for the year 1904–5 is given in the following table.

States and Provinces.	Factories operated.	Sowings. Acres.	Beets received. Tons, 2240 lbs.	Sugar produced. Tons, 2240 lbs.
New York	1	5,600	26,188	3,214
Wisconsin	3	13,900	95,025	9,598
Ohio	1	4,650	31,584	4,304
Michigan	16	82,600	377,847	46,659
Minnesota	1	3,500	30,804	3,304
Nebraska	3	14,150	104,480	13,355
Colorado	9	49,700	481,087	49,606
Utah	7	19,100	215,722	25,274
Oregon	1	2,800	18,635	2,348
Washington	1	4,000	24,107	2,679
Idaho	3	10,800	66,976	7,841
California	5	41,300	335,186	41,540
Total U. S.	51	252,100	1,807,641	209,722

It would be quite difficult to give general directions and rules for growing sugar beets applicable to all localities and conditions. Often expert sugar beet growers, at public meetings and in the agricultural press, give minute directions covering all the details of this intricate process. Others, each well versed in the process of growing sugar beets, get into arguments and disputes as to the right method. In such cases each may be correct in a measure. The occasion for such disagreements lies in the fact that each person has in mind the right method for a particular locality or set of con-

ditions. A careful study of the different sections of the United States where sugar beets are grown will lead to the conclusion that there is no single road to success in growing sugar beets. Every locality has settled conditions which will materially modify any set of methods that might apply to some other one. There are some settled rules, of course, but it is an actual fact that the various agricultural districts of this country will have to work out each for itself the right method. The person who argues that the ground must be plowed in the fall in order to receive the benefit of winter frosts is not offering any argument to the Pacific coast, for instance, where many beets are grown, and he who insists that the ground should be rolled in all instances after planting will hazard the crop if his directions are followed in many parts of Nebraska and other sections where the soil is sandy and there are strong winds. In such cases a smooth surface offers an excellent opportunity for the wind to carry along the sharp grains of sand, cutting off the plants and destroying the crop. There can be no general fixed rules applying to the kinds and application of fertilizers. General principles are all right when accompanied with the underlying reasons, but must always be modified to meet local conditions.

With the development of the industry in all the sections which have the necessary conditions, and the acquirement of ample experience both by the farmers in the production of beets and by manufacturers in the making of sugar, there will come many improvements, and eventually a cheapening of production, a result of great importance to all concerned in the success of the industry, because eventually the beet sugar industry of the United States will have to meet a sharper competition with foreign sugar producers.

It has already been stated that it costs about $30 per acre to produce sugar beets and to market the crop where rain conditions prevail. This is without taking into consideration the rent of the land, but it includes the farmer's time and everything else that enters into the cost of production. The average yield is about 12 tons per acre. Probably this cost of production will be gradually reduced because of improvements in implements and methods. The beets grown

have a gross value at the factories of $4 to $4.50 per ton (in states paying no bounty). This gives a gross return per acre of $48 to $54, and a net profit of $18 to $24. It must be kept in mind that these are averages of gross and net proceeds.

Taking what seems to be the most authentic figures, the cost of producing sugar beets in sections where they are grown by irrigation is about $40 per acre. An average of 13 tons per acre can be produced, having a higher sugar content, and worth $4.50 to $5 per ton, making the gross proceeds $58.50 to $65, and the net profit $18.50 to $25 per acre. These figures give to the farmer in each case a profit greatly more satisfactory than in the case of other crops. But the successful farmer will never be satisfied with the average proceeds of any crop, and it is to him we must look for the results that give the more encouraging inducements to beet culture. Many growers receive as high as $75 and some as high as $100 per acre for their beets, these high results depending upon the superior quality of the land and the superior skill of the one producing the beets.

Sugar beets are a very valuable crop to grow for stock feeding. It is estimated that they are worth two thirds as much for feeding as for the production of sugar. They may enter into a food ration for any kind of stock. The farmer growing beets for a sugar factory retains for feeding the beets that have been docked, or that are liable to be. He constructs root cellars and stores them away, and they enter largely into all animal food rations for winter feeding. For stock feeding, sugar beets have both a nutritive and a sanitary value.

After the beets are delivered to the factory and the sugar has been extracted, it is found that the pulp (which will amount to 50 per cent in weight of the beets worked) is almost as valuable for feeding purposes as the original beets themselves. It is a very cheap feed, and sells for 35 to 50 cents per ton. It enters naturally and profitably into the food rations of all kinds of stock. It is especially valuable for steers, lambs, brood mares, and brood sows, but reaches its highest use as animal food when fed to the dairy cow. The farmers in the neighborhood of a beet sugar factory feed large

quantities of it. They appreciate its nutritive and sanitary value. Pulp feeding gives an impetus to animal industry of all kinds. It offers a stimulus to the establishment of butter and cheese factories, to the erection of feeding pens, and to the whole stock feeding industry. Its use is one of the strong reasons for establishing the industry. The beet sugar industry opens up at once a large demand for labor, not only in the factory itself but on the farm. It is one of the things in which the farmer can invest with the assurance that he has a sure market and a fixed price for his crop to begin with.

The importance of the sugar crop to the United States, and the economic advantages to be gained from its entire production in our own country, is shown by the fact that the American is the world's greatest consumer of sugar. The average German uses 18 pounds of sugar annually, while the American's average consumption is 75 pounds. The American seems to be getting a constantly sweeter tooth, for the average citizen eats nearly twice as much sugar as he did thirty years ago. The total amount of sugar consumed in the United States in 1904 was 2,767,162 tons, of which only one fifth was produced in this country. The aim of the agricultural department in its active efforts to encourage the production of beet sugar is to manufacture all of this here. Making due allowance for failure of factories to reach in actual production their full capacity under ideal conditions, it would require 500 factories having a daily capacity of 500 tons of beets to produce the sugar imported, or a sufficient number of cane sugar factories to produce an equal amount of sugar. As a matter of fact, there is likely to be a rapid increase in both beet sugar and cane sugar factories. In order to equip and build these factories it will require an investment of capital of $250,000,000. This vast sum of money must be expended in this country for building materials and machinery and in the employment of the labor necessary to construct and equip the factories.

The rapid growth in consumption of sugar may strike one at first as hard to understand, but a closer investigation

reveals that it is one of the natural results of the rapid development that characterizes all the industries of this country. Not only is sugar used as an article of diet, but it is required in large quantities in the manufactures, arts, and sciences, this being the principal cause of the increased consumption. While it is a fact that the daily table use of this article grows as wealth accumulates, this would not by any means account for the large increase in consumption. Throughout the whole country, especially in the mountain and western states, there has been rapid development of very productive fruit districts. Irrigation has played an important part in extending the fruit industry. These orchards and patches of small fruits have been coming gradually into production. Many of them are distant from the markets. These products are of a perishable nature, and can not be distributed to consumers in a fresh state. Canning industries and preserving industries of all kinds have been installed to work up these products. Sugar is required in large quantities in preserving and canning fruits. Like other industries, the prepared fruit industry has to find a market. It has accomplished this not only at home, but to some extent in foreign countries. Each year sees a large increase in the supply of fruit that must be treated in this way, and each year has seen a consequently large growth in home and foreign trade in these products. It can be seen naturally that the increase in the demand for sugar in this direction has been enormous; yet the fruit industry is only in its infancy.

Experience throughout the United States has demonstrated that sugar beets do best in localities having certain climatic conditions. Up to date a large strip of land reaching across the northern portion of the country has given the most satisfactory results in growing sugar beets. It starts at the Hudson, takes in the southern half of New York, the northern portions of Pennsylvania, Ohio, Indiana, Illinois, Iowa, and Nebraska, the southern half of Michigan, Wisconsin, and Minnesota, all of South Dakota, large sections of Colorado, Utah, Wyoming, Montana, Idaho, Washington, and Oregon, and the coast side of California.

The mapping out of this belt is based on temperature conditions only. Throughout large areas included in the belt

other conditions make the growing of sugar beets either impossible or unprofitable. But there are many districts where this industry succeeds. The actual location of such can only be determined by experiment. There are valleys in the arid regions of the Rocky mountains having the right conditions, with sufficient water supply for irrigation, that have reached results never before equaled with sugar beets even in countries that have been working with the industry for a half century.

THE SUBSTITUTION OF DOMESTIC FOR FOREIGN GROWN FRUITS.

BY WILLIAM A. TAYLOR.

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The fruit industry, considered from the commercial standpoint, is of recent development in the United States. The colonists of the Atlantic slope and the Mississippi valley found a great variety and abundant supply of wild fruits and nuts in the forests. Those who came from England and other north European countries found indigenous representatives of most of their familiar fruits and nuts about their new homes, together with many which were new to them. They had but to gather of the abundance which surrounded them in summer and devise means for storing it for winter use. The pioneers of the lower Pacific coast, on the contrary, found few attractive indigenous fruits, and were dependent upon such as they introduced and cultivated for their fruit supply, which was, therefore, from an early day, chiefly exotic.

The chronicler of the expedition sent out by Raleigh to explore in the vicinity of Hatteras said of the grapes observed there that he had visited those parts of Europe in which this fruit was most abundant, and that the difference in quantity in favor of Roanoke was quite incredible.

Ralph Lane, in reporting his observations in 1585–86, pronounced the grapes of Virginia to be larger than those of France, Spain, or Italy.

John Smith found "chestnuts whose wild fruit equalize the best in France, Spaine, Germany, or Italy to their tast[e]s that had tasted them all." He early learned to discriminate between the green and the ripe persimmon, for he states: "Plumbs there are of three sorts. The red and white are

like our hedge plumbs; but the other, which they call Putchamins grow as high as Palmeta. The fruit is like a medler; it is first green, then yellow, and red when it is ripe; if it be not ripe it will draw a man's mouth awrie with much torment; but when it is ripe it is as delicious as an Apricot." He mentions also chinquapins, cherries, crab apples, and grapes, of which last named the colonists made "neere 20 gallons of wine, which was neere as good as your French Brittish wine." He describes at length the Indian methods of drying nuts and persimmons for the winter supply and of preparing them for food, and mentions among other summer fruits "strawberries which ripen in April" and "Mulberries which ripen in May and June;" he also mentions gooseberries and raspberries as abundant.

The New England colonists made similar reports. In the words of one who was at Plymouth in 1622, "The chestnut, hazelnut, beechnut, butternut, and shagbark yielded contributions to the store of food laid up for winter. Wild cherries, mulberries and plums enlarged the variety of the summer's diet. Wild berries, as the strawberry, the gooseberry, the raspberry, the whortleberry, the cranberry, grew in plenty in the meadow and champaign lands. Vines bearing grapes of tolerable flavor flourished along the streams." Rev. Francis Higginson, writing from the Massachusetts colony in 1629, says: "Excellent vines are here, up and down in the woods. Our governor hath already planted a vineyard with great hopes of encrease; also mulberries, plums, raspberries, corrance, chestnuts, filberts, walnuts, smalnuts, hurtleberries, and hawes of white thorne, neer as good as our cherries in England, they grow in plentie here." William Wood, who came in 1629, reports, "There is likewise Strawberries in abundance, verie large ones, some being two inches about; one may gather halfe a bushell in a forenoone. In other seasons there be Gooseberries, Bilberries, Resberries, Treacleberries, Hurtleberries, Currants; which being dried in the Sunne are little inferior to those that our Grocers sell in England." He seems to have been a man of discriminating taste, for, unlike other writers of the period, he tempered his praise of some with condemnation of others, as in the following lines:

"The Cherrie trees yield great store of Cherries which grow on clusters like grapes; they be much smaller than our English cherry, nothing neare so good if they be not fully ripe, they so furre the mouth that the tongue will cleave to the roofe, and the throat wax hoarse with swallowing those red Bullies (as I may call them), being little better in taste. English ordering may bring them to be an English cherry but yet they are as wilde as the Indians. The Plummes of the Countrey be better for Plumbs than the Cherries be for Cherries; they be black and yellow about the bignesse of a Damson, of a reasonable good taste. The white thorne affords hawes as big as an English Cherrie which is esteemed above a Cherrie for his goodness and pleasantnesse to the taste." In his account, "New England's prospect," we find that comparisons of latitude and climate were being made with a view to determine the possibilities of domestic wine production, for he says "vines afford great store of grapes which are very bigge, both for the grape and Cluster, sweet and good; These be of two sorts, red and white, there is likewise a smaller kinde of grape which groweth in the Islands, which is sooner ripe and more delectable; so that there is no knowne reason why as good wine may not be made in those parts as well as in Burdenaux in France, being under the same degree."

Roger Williams found the strawberry "the wonder of all the fruits growing naturally in these parts. In some places where the natives have planted I have many times seen as many as would fill a good ship within a few miles compass."

William Penn, writing in 1683, mentioned chestnuts, walnuts, plums, strawberries, cranberries, whortleberries, and grapes as growing naturally in the woods, and questioned whether it was best to attempt to improve the fruits of the country, especially the grapes, by the care and skill of art or to send for foreign stems and sets, already good and approved. It seemed to him most reasonable to believe that a thing grows best where it grows naturally, and that it would hardly be equaled by another of the same kind not naturally growing there.

The abundant and varied supply of indigenous fruits in the Mississippi valley and lake regions is still a matter of

recollection among the surviving pioneers and their descendants.

Recorded efforts to improve the native fruits by cultivation are more numerous in connection with the colonies in Virginia and Pennsylvania than in New England.

The abundance of indigenous fruits along the James naturally suggested to the colonists the wisdom of attempting their cultivation, and efforts in this direction were encouraged by the Virginia company. As the wine supply of the mother country came entirely from foreign lands the company sought to encourage the culture of the grape in the Jamestown colony. The first efforts in this direction seem to have been made with the native grapes, the productiveness, size, and quality of which were so highly praised by the early settlers.

Lord Delaware, who arrived in 1610, brought with him French vinedressers, who, soon after their arrival, proceeded to transplant the native vines. We have no record of the outcome of this experiment nor of that of Dale, who, soon after the settlement at Henrico, in 1611, established a vineyard of 3 acres, in which he planted the vines of the native grape to test their adaptability to the production of wines that could be substituted for those of France and Spain.

In 1619 the Virginia company sent several French vinedressers, with many slips of the finest vines that Europe afforded. These vinedressers reported that the grapes of the colony far excelled those of their native Languedoc, both in abundance and variety, and that they had planted their cuttings at Michaelmas and obtained grapes from them in the following spring. By an act of the assembly of that year every householder was compelled by law to plant ten cuttings and to protect them from injury. He was expected at the same time to acquire the art of dressing a vineyard, either by special instruction or by personal observation. Such favor in the shape of bounties was bestowed upon those who actively engaged in vine culture that vineyards were established containing as many as ten thousand vines.

The wines sent to England failed to equal the expectations of the promoters, their inferior quality being ascribed at the time to the defective manner of manufacture. Some

ascribed it to the perverseness of the vinedressers, who were thought to have concealed their knowledge out of spite against their employers, and by way of punishment the assembly refused to grant them permission to cultivate tobacco, to which crop they had probably turned to gain a subsistence. Penn's inclination to favor the cultivation of native rather than introduced fruits has already been noted. But the failure of the native grapes to yield a good quality of wine whenever tried seems to have diverted attention from their improvement and that of other native fruits for about a century, and to have stimulated efforts to introduce the fruits of the old world in the several colonies.

The first recorded effort at introducing foreign fruits was made by the Jamestown colonists in May, 1607. Within two weeks after their arrival on Jamestown Island they had cleared land for sowing English wheat, and had reserved a space for a garden, in which were planted seeds of fruits and vegetables not indigenous to the country, including the melon, the potato, the pineapple, and the orange. These had doubtless been obtained by the colonists at Dominica or elsewhere in the West Indies while en route. The fate of the effort, so far as the pineapple and orange are concerned, may safely be left to the imagination.

In 1622, in compliance with the request of the authorities of the colony, the Virginia company made provision for dispatching to Jamestown a pinnace containing not only wheat and barley, but also garden seeds and scions of fruit trees. What success attended this effort is not recorded, but it is not unlikely that the apples, pears, peaches, apricots, vines, figs, and other fruits which Smith stated in 1629 "some have planted that prospered exceedingly" resulted from it. Certain it is that in 1647 the apple is recorded as grafted upon wild stocks in Virginia, while in 1686 William Fitzhugh, in describing his own plantation, mentions "a large orchard of about 2,500 apple trees, most grafted, well fenced with a locust fence." By the close of the seventeenth century there were few plantations in Virginia without orchards of apple, peach, pear, plum, apricot, and quince.

Frequent attempts were made to introduce in cultivation the fruits of the Mediterranean region. Importations of trees or cuttings of olives, lemons, oranges, pomegranates, and figs are frequently mentioned in the colonial records, but of these none but the fig is recorded as being successfully grown. Of this fruit, Smith wrote in 1629 that one Mistress Pearce, of Jamestown, an honest, industrious woman, had gathered from her garden in one year "neere an hundred bushels of excellent figges."

Of early introductions to New England, a memorandum was made March 16, 1629, "to provide to send for New England, Vyne Planters, Stones of all sorts of fruits, as peaches, plums, filberts, cherries, pear, aple, quince kernells, pomegranats, . . . also currant plants." It is a reasonable inference that these were sent, and that some of these and others succeeded with the colonists, for John Josselyn states in 1639 that the master of the ship in which he sailed from Boston, October 11, 1639, "having been ashore upon the Governors Island, gave me half a score very fair Pippins which he brought from thence." After his second sojourn in New England, 1663–1671, he stated, "fruit trees prosper abundantly, Apple-trees, Pear-trees, Quince-trees, Cherry-trees, Plum-trees, Barberry-trees. I have observed with admiration that the kernels sown or the Succors planted produce as fair & good fruit without grafting as the Tree from whence they are taken; the Countrey is replenished with fair and large Orchards." "The Quinces, Cherries, Damsons, set the Dames a work; Marmalad and preserved Damsons is to be met with in every house." While on board ship, Josselyn was informed by one Mr. Woolcut (a magistrate in Connecticut colony) that he had made 500 hogsheads of cider from his own orchard in one year.

According to family tradition, a pear tree which stood near the mansion on Governor Endicott's farm was imported in 1630. Certain it is that Endicott soon after this propagated young trees (probably seedlings) and furnished them to other colonists both by gift and in exchange for land. Frequent importations of seeds, scions, and grafted trees, together with propagation from those already noticed, both by seeds and

grafts, brought the orchards of New England up to such point that Dudley, in 1726, stated in a paper in the Philosophical Transactions, "our Apples are, without doubt as good as those of England, and much fairer to look to, and so are the Pears, but we have not got all the Sorts. . . . Our People of late years, have run so much upon Orchards, that in a village near Boston, consisting of about forty Families, they made near ten Thousand Barrels of cider."

Perhaps the earliest recorded grafted tree brought from Europe (that of Governor Endicott is stated to have been a seedling) was the summer bonchretien, planted by Governor Stuyvesant in 1647 in New Amsterdam. It is said to have been brought from Holland, and its trunk remained standing on the corner of Third avenue and Thirteenth street, New York city, until 1866, when it was broken down by a dray. Many of the earliest introductions of named varieties of the pear, including White Doyenne, St. Germain, Brown Beurre, Virgouleuse, etc., were made by the French Huguenots, who settled about Boston and New York shortly after the revocation of the edict of Nantes in 1685.

The early French colonists established orchards and vineyards along the rivers and lakes of the interior soon after their arrival. Through the agency of trappers and appreciative Indians, these fruits were soon widely distributed. Seedling trees of apple, pear, and peach were found bearing fruit in isolated localities throughout the Mississippi valley and in the vicinity of the great lakes when the later settlers migrated there previous to the year 1800.

There is ample evidence that by the beginning of the present century few established homesteads in the eastern United States were without a home supply of apples in their season, while many had peaches, pears, plums, cherries, and other fruits. But aside from the sale of cider made from apples, brandy from peaches, and, in a few localities, wine from wild or cultivated vines of the native grape, commerce in domestic fruits or their products could hardly be said to exist.

The beginning of the foreign fruit trade of the United States is with difficulty distinguished at this time, but it seems to have started with the receipt of a shipment made in 1621

by the governor of Bermuda to the Jamestown colony. It consisted of "two great Chests filled with all such kinds and sorts of Fruits and Plants as their Ilands had; as Figs, Pomegranats, Oranges, Lemons, Sugar-canes, Plantanes, Potatoes, Papawes, Cassado roots, red Pepper, the Prickell Peare, and the like." This was followed within a few months by the arrival in Bermuda from Virginia of "a small Barke with many thanks for the presents sent them; much Aquauitae, Oile, Sacke, and Bricks they brought in exchange of more Fruits and Plants, Ducks, Turkies, and Limestone; of which she had plenty and so returned." As intercourse was frequent, there was undoubtedly a considerable import trade in such fresh fruits of the tropics as would endure sail transportation between the more southern coast colonies and the West Indies, though little is on record to bear witness to the fact.

At what time the trade in the fruit products of southern Europe began is not known, but it was doubtless at an early day. The inventory of the Hubbard store, York county, Va., in 1667, discloses the following items: "Twenty-five pounds of raisins, one hundred gallons of brandy, and twenty gallons of wine."

As most of the dried and preserved fruits of the Mediterranean region were then considered luxuries rather than necessities, it is likely that the trade in them did not become important until the colonies had accumulated considerable wealth. It probably became an important item before the revolution, and was, no doubt, seriously interfered with during the second war with England. It is a tradition among the fruit dealers of New York city that when it was desired to celebrate the signing of the treaty of peace in 1814 by a grand banquet, only a half barrel of raisins and currants and a box or so of citron could be found in the city for the making of a plum pudding.

In 1821, when the Treasury department published its first statement of imports and exports, the imports of fruits and nuts, of which currants, raisins, figs, plums, prunes, and almonds are separately stated, amounted to 2,878,873 pounds, valued at $181,035. At about this time notices of auction

sales of the fruits mentioned, and of oranges, lemons, Malaga grapes in jars, tamarinds, citron, Madeira nuts, and filberts were of frequent occurrence in the market reports of New York city.

The export trade seems to have begun with the apple, as a large supply existed in close proximity to the seaport towns. Trade in this fruit with the West Indies probably developed early in the eighteenth century, though we have no record of shipments until 1741, when it is stated that apples were exported from New England to the West Indies in considerable abundance. No transatlantic shipment has been disclosed earlier than that of a package of Newtown Pippin of the crop of 1758 sent to Benjamin Franklin while in London. The sight and taste of these brought to John Bartram, of Philadelphia, an order for grafts of the variety from Franklin's friend Collinson, who said of the fruit he ate: "What comes from you are delicious fruit—if our sun will ripen them to such perfection." Subsequently a considerable trade must have resulted, for in 1773 it was stated by the younger Collinson, that while the English apple crop had failed that year, American apples had been found an admirable substitute, some of the merchants having imported great quantities of them. In his words: "They are, notwithstanding, too expensive for common eating, being sold for two pence, three pence, and even four pence an apple. But their flavor is much superior to anything we can pretend to, and I even think superior to the apples of Italy."

The introduction of the raisin varieties of grape to California is credited by Eisen to Col. Agoston Haraszthy, who, in 1852, imported vines of the Alexandria muscat from Malaga, and in 1861 brought cuttings of Gordo Blanco from the same place. Numerous importations were made in subsequent years by different persons, but not until 1863 is there record of the production of cured raisins. In that year the late Dr John Strentzel, of Martinez, exhibited at the California state fair specimens of muscat raisins, together with the dried fruit of four other varieties of grapes, to show the contrast between raisins and dried grapes.

Currants, though long tested in a small way, have not been largely produced in this country. Vines of Sultana and Corinth grapes were imported as early as 1854 by the patent office and distributed in the middle and western states, but like other varieties of the vinifera species did not succeed. At present prices there is little inducement for their production in California, but recent experience in certain localities in that state indicates that any marked rise in price would be followed by a considerable production of currants.

The importance and rapid increase of the imports of prunes led to early efforts at their production in this country. Coxe, whose work was published in 1817, describes as grown in his time two varieties, prune plum and prune suisse, but does not discuss their usefulness for drying.

In 1854, when scions of prune d'Agen and prune Sainte Catherine were imported by the patent office and distributed principally in the states north of Pennsylvania and certain districts bordering on the range of the Alleghany mountains, in order to be engrafted upon the common plum, great hopes were held that this region would soon produce an abundance of the cured fruit. It was estimated at that time that the state of Maine alone, where the curculio was rarely seen, was "capable of raising dried prunes sufficient to supply the wants of the whole union."

But though the trees thrived and produced fruit, as in the case of the fig in the south, the climatic conditions of the eastern United States were found unfavorable to the production of the cured product.

The commercial production of prunes in this country may therefore be said to trace to a package of scions brought to San Francisco from France in 1856 by Pierre Pellier, and by him sent to his brother Louis at San Jose, Cal. But not until 1870, according to Lelong, was a large orchard planted. This was near San Jose, and its success led to the planting of numerous others from 1878 to 1881, since which time the industry has been firmly established on the Pacific coast. The first cured prunes were exhibited at the California state fair in 1863, and are said to have been of the German variety. As recently as 1881 the output of the largest growers in Cali-

fornia did not exceed 5 or 6 tons of cured fruit per annum. The California production for 1900 was 5,632,036 bushels, grown on 9,823,713 trees. The Golden State supplies the nation with more than one half the total consumption.

In California the fig was introduced by the Franciscan missionaries from lower California, who, led by Junipero Serra, established a mission at San Diego in 1769 and later at twenty other points within the present boundaries of the state. The most widely grown and popular variety in the state until comparatively recent times was known as the California Black, or Mission, fig, but it has largely been replaced by the sort known in California as Adriatic, which, according to Eisen, was twice imported from Italy between 1867 and 1877. This variety is at present the most widely planted drying fig in California. It has many points of merit.

A large importation of cuttings from Smyrna was made in 1882 by G. P. Rixford and distributed throughout the state. Since then other importations have been made, trees from which are growing at different places. Among these importations several valuable figs are found, one of which, at least, is of superior quality for drying; but so far as tested they fail to produce fruit unless artifically pollinated. Rather more than half the figs we eat are now grown in America, our production in 1899 being 13,016,274 pounds, of which 10,620,366 pounds were raised in California.

The sour orange is supposed to have been introduced to Florida soon after the settlement of St. Augustine in 1565. The species found a congenial home, and was soon widely scattered throughout the peninsula. The sweet orange was undoubtedly introduced at a later date, and being easily propagated both by seeds and buds was generally distributed throughout the settled portions before the beginning of the present century. Commercial orange culture as now practiced did not begin until after the acquisition of Florida by the United States, and at first was confined to such eligible sites as existed along navigable water which afforded transportation for the fruit. After the close of the civil war the industry grew with wonderful rapidity as railroads and steamboats made possible the shipment of the fruit for longer dis-

tances. A considerable production of oranges was developed in a limited district in southern Louisiana previous to 1886, but since the freeze of that year the crop of that district has been of little commercial importance.

In California the orange was planted in the mission gardens at an early date, and according to a recent writer in the Fruit Trade Journal the first orchard was planted at San Gabriel in 1804. An orchard was planted at Los Angeles by Don Louis Vignes in 1834.

The present era of commercial orange growing in California dates from the foundation of the Riverside colony in 1872. The orange was largely planted early in the history of the colony, and after the adaptability of the Bahia (synonymous with Washington navel, Riverside navel, etc.), two trees of which were sent to Riverside by Mr. William Saunders, of the department of agriculture, in 1873, was demonstrated, it soon became, as it continues to be, the leading fruit of the district. Oranges are grown commercially in several portions of the state, but chiefly in southern California.

Lemon production on a commercial scale in Florida is commonly traced to the introduction of choice Mediterranean varieties by General Sanford about 1874. Much difficulty was for some years experienced in determining the proper methods of curing and marketing the fruit, and just as a reasonable degree of success was attained the freezes of 1894 and 1895 destroyed a very large proportion of the groves of the state. As the lemon is less hardy than the pomelo and orange, comparatively little interest in its culture has been manifested in Florida since 1895.

In California commercial lemon culture is also of comparatively recent date, a beginning having been made at National City by F. A. Kimball in 1869, and practically our whole crop comes from that state.

In view of the development of commerce with the West Indies at an early day it is probable that the pineapple, notwithstanding its perishable nature, was one of the first fruits that reached the south Atlantic ports.

Cultivation of pineapples in a small way in Florida probably began at an early day. A note in the New England

Farmer for 1850 says: "The cultivation of the pineapple has been commenced in Florida, and with a little protection occasionally in winter, it is believed this delicious fruit can be raised in that state in abundance." This probably referred to efforts in the vicinity of St. Augustine, where the winter temperature is now known to be too low for this species.

In 1860 planting began on the Keys and proved so profitable that the area devoted to it has steadily increased, while its culture has extended northward along both the Atlantic and gulf coasts of Florida, and, with shed protection, has been very successful at several points in the interior as far north as Orlando.

The imports of fresh grapes consist almost entirely of the large and meaty grapes of Almeria, commonly known in our markets as Malagas. Auction sales of such in jars, at 35 to 40 cents per pound, were of frequent occurrence in New York early in the present century.

On account of their firmness and long keeping quality, these grapes occupy a position in our markets peculiar to themselves. At the present time they can hardly be said to compete with any domestic product, though by aid of refrigeration some of the meaty and late ripening sorts of the vinifera type may be expected to lessen the demand for Malagas in future. Though efforts at the commercial production of this type in California for shipment in the fresh state late in the season have not been eminently successful, no adequate reason is known for believing that they will not be so in future when the climatic and soil conditions essential to their successful growth are better understood.

As early as 1634 an attempt was made to introduce the olive to Virginia, and at frequent intervals down to the present century its culture was attempted at different points in that state. In 1755 it was introduced at Charleston, S. C., by Henry Laurens, and again at the same point in 1785 by an incorporated society for the promotion of agriculture. In 1769 it was introduced by Dr. Turnbull, an Englishman, who founded a colony of Greeks and Minorcans at New Smyrna, Fla., but nowhere in the eastern states has it become of commercial importance.

In 1769 olive seeds were planted at San Diego, Cal., and some of the trees which grew from them are still in existence. These and others about the California missions demonstrated the suitability of the soil and climate to olive production at an early day, but not until after the American occupation of the territory did olive culture assume commercial importance.

In 1872 Mr. Ellwood Cooper, of Santa Barbara, planted olive trees, from the fruit of which he made oil in 1876, and since that time the olive has become a favorite tree with planters in several counties in the state. Statistics of production are not obtainable, but the output of oil and pickled olives is increasing largely each year. In 1900 there were 1,500,000 olive trees producing over 5,000,000 pounds.

The superior cleanliness observed in the manufacture of oil in California, together with the guaranteed purity of the product, has been causing the domestic article to largely supplant the imported oil in our markets. The consumption of pickled olives in the United States is increasing rapidly, and the introduction of the variety from which the celebrated Queen olives of Spain are made, together with the superior quality of the pickled ripe olives packed in California, are resulting in the displacement of the imported article.

On account of its close relationship to the peach, the almond was at one time regarded as a very promising tree for the eastern United States. Previous to 1855, the patent office distributed an importation of soft shelled almonds to growers throughout the middle and southern states. Its early blooming habit and susceptibility to injury by late frosts soon demonstrated the fact that though the tree succeeded it was valueless as a producer of nuts even in the gulf states. In California many of the earlier efforts at commercial almond culture were unsuccessful, either because they were made with unreliable varieties or in unsuitable localities. But in 1885, when Mr. A. T. Hatch exhibited a collection of thin shelled seedlings from the bitter almond which had proved to be of superior quality for market, and bore regular crops, new life was given to the industry.

The production in California is in excess of 5,000,000 pounds annually; of the total product of the United States

97.9 per cent is grown in California, and the quality of the product compares favorably with all but the best of the imported nuts.

Almonds are also successfully grown in rather limited areas in Texas, New Mexico, Arizona, Nevada, Utah, Idaho, and Oregon.

Although scattered trees of the Persian (English) walnut were planted in the eastern United States at an early day, no commercial plantings resulted from them. Like the almond, their blossoms suffer from late frosts too frequently to permit regular crops, though in a few sheltered localities the trees are rarely injured, and are reasonably productive.

In California the walnut was introduced at the missions, and several commercial orchards are recorded by Lelong as having been planted from 1843 to 1865. The earlier plantings were of the Mission, or English type, and in many localities the trees were found to lack productiveness. More recently, improved sorts producing more regular crops of soft shell nuts were introduced, and since their general planting began walnut culture has greatly increased. California produces 99.6 per cent of the American crop.

The domestic production of cocoanuts, which is confined to the coast region of lower Florida, is unimportant.

The development of the fruit export trade of the United States is a subject of surpassing interest to the students of agricultural economics. As has been noted, the export trade began with the shipment of apples and was for many years limited to that fruit. Shipments of ice from New England ports to the West Indies, which began in 1805, were accompanied by large quantities of apples, and soon after the extension of the ice trade to India and China, which occurred in 1830, American apples could be had in the ice ports of those countries.

It was stated in 1843 that the fruit dealers of Boston had at that time been shipping apples and cranberries to Europe for many years. In 1845 Newtown pippins from the orchard of Robert L. Pell, of Ulster county, N. Y., which contained 20,000 trees, sold in London at $21 a barrel. At a later date shipments of the same variety and others from the Piedmont

and mountain regions of Virginia were begun, and these districts have in recent years furnished the principal supply of pippins for export. Since 1881 the shipments of apples have constituted an important item of the transatlantic trade. The eastern states still furnish the larger part of the apples exported, but frequent shipments are now made from the great orchard districts of the Mississippi valley, and some profitable export shipments have recently been made from the Pacific coast.

In addition to apples, some other fruits, such as cranberries, peaches, plums, pears, and oranges, are shipped in the fresh state, the supply of all but the first named coming chiefly from California.

Exports of dried fruits were at first confined to the apple, and after the perfecting of the fruit evaporator, which occurred about 1870-1875, increased rapidly. Notwithstanding the attempted discrimination against them by foreign governments since that time, the wholesomeness and cheapness of American dried apples have caused a marked increase in their consumption abroad, as is evident from the large quantity exported.

The development of the canning industry has resulted in a very great increase in exports of canned fruits. There are 2,000 canneries of fruit and vegetables in the United States in which a capital of $30,000,000 is employed with an annual production of $60,000,000. The census of 1900 showed the number of wage earners they employed varied from a minimum of 5,643 in February to 116,550 in August. California is the leading state in the industry, although Maryland is a close rival, the latter state being known as the cradle of the canning industry.

GRAPE AND RAISIN PRODUCTION IN THE UNITED STATES.

BY GEORGE C. HUSMANN.

[George C. Husmann, pomologist and viticulturist; born Husmann, Gasconade Co., Mo., April 27, 1861; attended public schools at Bluffton, Montgomery Co., Mo.; public and high schools at Sedalia, Mo.; graduated from Missouri state university June 1, 1882; received degree of Master of Agricultural Science, June 4, 1885; has written numerous articles, bulletins, addresses, etc., on grape growing, wine making and kindred subjects.]

When America was discovered the wild vine was so prominent a feature of the vegetation that the name Vineland was more than once applied to the country. Considerable wine was produced from a native grape in Florida as early as 1564. The London company planted vineyards in Virginia prior to 1620, and many succeeding attempts at grape growing were made by William Penn and by German and Swiss settlers. Of more recent attempts to cultivate the vine on the Atlantic coast, the first were confined to European varieties, and were not successful. The Mission fathers in California were the first to grow successfully the European grape in the United States. They grew grapes at the missions for their own use only, the work being principally done by Indians. They had but one variety, which is still largely grown, and is known by the name of Mission. It is first heard of as introduced into Mexico in 1520. Chronologically, it was brought to the California missions, as follows: San Diego, 1769; San Gabriel, 1771; Los Angeles, 1781; and Santa Barbara, 1786. The Mission vine planted at Montecito, Cal., in 1795, was exhibited at the Centennial exposition in Philadelphia. It was 18 inches in diameter, and in one season had produced over five tons of grapes. From the missions, the viticultural pioneers received their inspiration as well as their start of cuttings.

Mr. John Adlum made the first really successful efforts at grape growing on the Atlantic coast. In 1820 he planted a vineyard near Georgetown, D. C., consisting mostly of

native vines. His introduction of the Catawba variety into general cultivation was the beginning of a new era in grape history. In a letter written by him to Nicholas Longworth in 1825, he says that "in bringing this grape into public notice I have rendered my country a greater service than I would have done had I paid the national debt." Since its first introduction, grape culture has gradually increased, and interest in it has become general throughout the land. Such rapid progress was made that in 1830 Mr. W. R. Prince, in his treatise on the vine, enumerates 88 varieties of American vines. Today there are at least 1,000.

Mr. Ephraim Wales Bull is deserving of lasting gratitude for raising from seed and giving to the world the Concord grape, the most widely known, most generally planted, and, for all purposes, the best American grape yet introduced. Only a few miles from Concord, Mass., stands Bull's cottage, in the dooryard of which still grows the first Concord vine, from which stock the unnumbered millions of vines of this variety came. On one side hangs a square oak board on which these words are artistically burned:

"I looked about to see what I could find among our wildings. The next thing to do was to find the best and earliest grape for seed. This I found in an accidental seedling at the foot of the hill. The crop was abundant, ripe in August, and of very good quality for a wild grape. I sowed the seed in autumn of 1843; among them the Concord was the only one worth saving.—Ephraim Wales Bull."

The Concord is included in nearly every collection where American vines are planted. To illustrate what a boon it has proved to be, it need only be stated that the Chautauqua grape belt, on Lake Erie, in 1900, produced 192 million pounds of grapes, at least nine tenths of which were Concords. Mr. George Husmann, the father of the writer, in 1865, said: "One third acre of Concord, planted five years ago, has produced me, in fruit, wine, layers, and plants, the round sum of $10,000 during that time."

In the United States there are two distinct grape producing sections, one east of the Rocky mountains, where the American varieties are largely and profitably grown, the other

in California, where the Vinifera varieties have found a congenial home. These sections differ not only in their products, soils, and climate, but also in their methods of pruning, culture, gathering, working, and marketing of crops, so that only those familiar with both sections are able to make a just comparison.

The decade closing the first half of the last century witnessed the birth of commercial grape culture in the United States, leading up to the making of choice wines from American grapes. The manufacture of sparkling wine and unfermented grape juice has been developed in the eastern states, while the Pacific coast has entered into direct competition with the choicest European wines, and has captured the raisin market of this country. The efforts of Longworth and others at Cincinnati in grape growing and wine making were followed by many in other states, especially in New York, Missouri, Virginia, Indiana, Illinois, Kentucky, Pennsylvania, the Carolinas, and Michigan. In California, where the Mission had so far been the only variety cultivated, introductions of the choicest European varieties soon followed. In 1850 the country produced almost 250,000 gallons of wine. In 1860 the product had reached over one and one half million gallons, and all the states and territories except four were growing grapes. The census of 1860 shows California, New York, and Ohio as the three leading wine producing states. From 1860 to 1875 rapid progress was made. In 1870 Missouri produced more than any other state except California. With this exception, California, New York, and Ohio have taken the lead. In 1900 their combined output was 22,404,085 gallons of wine out of a total of 23,425,567 gallons for the whole country.

To sum up, American wines and brandies have taken high honors at all important expositions, including that at Paris in 1900, and they are rapidly finding their way into all the principal markets of the world.

Soil, location, and site will differ greatly with the object in view. Some varieties of grapes may be grown on almost any soil. Usually those lands are selected that can be prepared and planted with the least labor, that are the easiest to cultivate, and which produce the largest crops. Quality and quantity, however, in most cases do not go hand in hand.

The best soils are a gently sloping, well drained calcareous loam, of sufficient depth, with porous subsoil; gravel or small stones in a soil are not a detriment. Some prefer a sandy soil with a gravelly substratum. The place should have a good water supply, be easy of access to market, and free from late spring frosts. The cellar or packing house should be centrally located on the place, and if possible so that the grapes can be hauled down grade, or at least on a level. For this purpose a hillside into which a cellar can be excavated, facing so that each story can be easily approached by wagon, is to be preferred.

The soil should be well prepared. It should be cleared of large stones, stumps, and other obstructions, and not only be thoroughly and deeply plowed, but subsoiled as well. If it be virgin soil it will be of benefit to raise a crop of grain on it the season previous to planting, as this gives a better opportunity to put it in good shape. Any wet spots should be carefully drained. After being plowed and subsoiled it should be thoroughly harrowed and the clods crushed with drag or roller.

On partially exhausted or poor soils such manures and fertilizers should be applied as will give them those substances in which they are deficient. Broadly speaking, if the soil lacks in fruit producing qualities, potash is needed; if more wood growth is desired, nitrogenous fertilizers should be applied.

As to varieties of grapes to plant, each locality must in a measure determine this for itself, grape growing being perhaps more dependent on selection of varieties with reference to soil, climate, location, and other conditions than any other fruit industry. The writer has seen such radically different results with the same varieties, planted in vineyards only a short distance apart, that it would hardly seem possible they were the fruit from the same variety.

It must be decided whether to grow raisin, table or wine grapes. Usually it will be well to select such varieties as have proved valuable for such purposes in the immediate vicinity. Should a grower embark in an entirely new district, where grape growing has not been tried, he will have an opportunity

for displaying good judgment, and perhaps gain the distinction of becoming a pathfinder for those who follow in his lead, or perhaps, like Mr. Bull with his Concord, will raise a new variety adapted to the locality.

The American varieties most generally grown are Concord, Catawba, Moore Early, Missouri Riesling, Elvira, Isabella, Delaware, Norton, Niagara, Herbemont, Lenoir, Ives, Clinton, and Eumelan; the Vinifera varieties are Zinfandel, Valdepenas, Petit Sirah, Beclan, Mataro, Petit Pinot, Carignan, Mission, Chablis, Semillon, Sauvignon Vert, Green Hungarian, Berger, Thompson seedless, Alexandria (Muscat of), Sultana, Feher Zagos, Flame Tokay, Emperor, and Cornichon.

Throughout the eastern states vineyards are usually planted in rows 8 feet apart, with the vines 8 to 10, even 12, feet apart in the rows. A plain trellis of posts, 24 by 30 feet apart, with two parallel wires, the first 18 to 20 inches from the ground and the second 36 inches, is mostly used, but in some instances a grower uses three wires. Of late years many use the Munson trellis or a modification of it. In California the usual method has been to plant 7 feet apart each way, no trellis but simply stakes being used. This enables growers to plow and cultivate lengthwise and crosswise. There is a tendency to plant farther apart, some planting 8 by 8, others 6 by 10, and others 9 by 9 and 8 by 10. The writer prefers to plant 6 by 10 in most localities. This divides the distance in such a manner as to make the plowing, cultivation, etc., better, easier, and cheaper. The vineyards are all plowed twice. In the first plowing the soil is thrown away from the vines, and in the second it is thrown up to them again. The vineyards are cultivated frequently early in the season. In the eastern states too late cultivation, it is claimed, keeps the vines growing too late in the season, causing much unnecessary growth of wood, which does not ripen and weakens the vine. In California cultivation is abandoned after the spring rains are over.

So many different methods of pruning and grafting are practiced that the details of them can not be discussed in this paper. In the eastern states the Kniffin system or some modification of it is mostly used. However, this varies

greatly. In California two principal methods are practiced, commonly called cane and spur pruning. All of the systems have one underlying principle. As the grape bears its fruit mainly on shoots on the wood of the previous year's growth, the pruning should be so as to renew the wood at a given point from year to year, thereby regulating its production and keeping the plant thoroughly shaped and under constant control. With a thorough knowledge of the nature of the vine nothing is easier than to prune it correctly. Perhaps the nature of no fruit bearing plant is so poorly understood by the average horticulturist as the vine. There are many who easily learn to prune fruit trees who fail to master the vine, and the same statement is equally true of grafting.

In many of the eastern states the black rot, anthracnose, and mildew have wrought such serious damage that many vineyards have been abandoned. In some sections the grape rootworm and the thrips have been very destructive. In California the Phylloxera and the Anaheim disease have worked very serious and extensive injury, and it will require systematic experiments and earnest work and study to cope with them.

In picking, the grapes are placed either in boxes or trays. Those selling in baskets accept the price of the day as satisfactory or send to commission houses to sell on commission, others who are fortunate enough to have built up a reputation sell on direct orders at fixed prices. Those disposing of the product in bulk sell the entire crop at a stipulated price per ton delivered at the wineries or aboard cars, and receive their settlement after the last of the grapes have been delivered. Quite a few sell their crops on the vines at so much an acre, or a stipulated sum for the entire crop, the buyer in such instances doing all the work, picking, hauling, etc., and assuming all risks.

The methods of picking and packing practiced in the leading table grape districts of the country are as follows: Grapes are picked in trays, all the stems being placed upward; the grapes are then allowed to wilt at least forty eight hours, but are often stored away in the trays in cool, dry rooms, frequently as long as two months, and in extreme cases even

longer. From these trays the grapes are carefully picked over, all decayed and inferior berries being removed; they are then packed in four pound baskets for shipment. In some of the less up-to-date sections, larger sized baskets are still used. Some of the buyers have their own packing houses, but as a general rule each grower does his own packing, the baskets and labels being furnished by the buyer. In order to insure honesty and good quality, each packer receives his number, which goes on every basket furnished by him. The baskets are loaded into the cars and sent directly to the principal markets.

Almost all the raisins of the United States are produced in California. In fact, so few are grown outside of the state that it can be called a California industry. Few branches of horticultural industry in this country have so completely captured the home market as this one.

The introduction of raisin grapes was really only a part of the introduction of choicer varieties of Viniferas into California. In 1851 Col. A. Harazthy grew Muscatels from the seed of Malaga raisins. On March 25, 1852, he imported the Alexandria (Muscat of), and on September 27, 1861, the Gordo Blanco and Sultana from Spain and the white and red Corinth from the Crimea. He was the first to introduce raisin varieties into the state. Another importation of Alexandria (Muscat of) was made by A. Delmas in 1855 and planted at San Jose, Cal. G. G. Briggs, of Davisville, imported the Muscatels from Spain, while R. G. Blowers, of Woodlawn, started the raisin vineyard of Gordo Blanco with cuttings received from Col. Harazthy. These were the first two successful raisin vineyards in the state. Both of these vineyards produced raisins as early as 1867, but it was not until 1873 that their raisin crops cut any figure in the market, when they amounted to nearly 6,000 boxes. In the fall of 1873, 25 acres of Alexandria (Muscat of) were planted in the Eisen vineyards, near Fresno. In 1876 and 1877 T. C. White planted the Raisina vineyard with Gordo Blancos, and in 1877 and 1878 Miss M. F. Austin planted the same variety at the Hedge Row vineyards. Col. William Forsyth interested himself in raisin growing in 1882. From that time on raisin vineyards multi-

plied so rapidly near Fresno that in 1887 raisin production was recognized to be the leading industry of that neighborhood. In 1873 John North planted Alexandria (Muscat of) at Riverside, and three years later raisin grape growing had become general there. R. G. Clark planted the first Muscats in El Cajon valley in 1873, but most of the vineyards of that district were not planted until 1884 to 1886. In Orange county, McPherson Brothers made their first plantings in the seventies near McPherson. The industry grew so that Robert McPherson, the largest grower, became at one time not only the largest packer and dealer in the district, but the largest in the state.

Many changes have occurred since the establishment of the raisin industry in Orange county, and now Fresno has become the center, the conditions there being exceptionally well suited to the growing and the curing of raisins. The raisin producing section comprises ten counties—Fresno, Kern, Kings, Madera, Merced, Orange, San Bernardino, San Diego, Tulare, and Yolo. The profits from an acre differ materially, varying from \$50 to \$500, a fair average being from \$125 to \$150. It takes from three to four pounds of grapes to make one pound of raisins. The product of about 65,000 acres is at present converted into raisins, it being desired to cure only enough to meet the demand. The demand for the last five years has been about eighty million pounds or only one pound per capita for the United States.

In the raisin producing section of California the country is so level naturally that not much leveling is necessary. The soil varies considerably, the deep gray alluvial bottom land being considered the best for Muscatel grapes. The pruning, planting, and cultivating of a raisin vineyard is much the same as in other California vineyards.

Crops can be grown without irrigation, but it is practiced because it increases the size of the fruit, and therefore increases the yield. Two irrigations are necessary, one early in the summer and another when the berries begin to ripen. Before irrigation was so extensively practiced, water was usually found at a depth of about 18 feet; now much trouble is experienced in some localities on account of the lands becoming

water logged. In the hottest time of the summer the thermometer has stood as high as 114 degrees F. in the shade for a day or two at a time. The highest average is about 90 degrees F., while the average in July and August is about 85 degrees F. in the shade. The nights are always much cooler than the days. The coldest weather in winter is 18 degrees F. above zero. The summers are rainless and the nights are so free from dew or moisture that a piece of tissue paper after lying all night is crisp and stiff the next morning, without a particle of moisture showing. The rainfall averages 13 inches. The principal rains occur in January and February, with some showers in October. Frequently it rains enough in November to cause considerable damage to partially dried raisins and grapes. It is then that the Japanese laborers watch the predictions of the weather bureau and when rain is indicated ask as high as 50 and 75 cents an hour for turning and covering the trays of raisins that are out in the vineyards. So familiar has this practice become that the school children who are large enough get excused from school for the work. In fact, the labor question is one of the most serious problems the growers have to contend with. The Chinese and Japanese laborers (especially the Japanese) control the situation, and make from $2 to $3.50 and even as high as $4 per day picking grapes.

Grapes are ripe by the middle of August, the season often lasting into November. The average time of drying and curing a tray of raisins is about three weeks, all depending on the weather. The earliest picked grapes dry in ten days, and the later ones often take four weeks and even more. The method of drying is very simple. The bunches are cut from the vines and placed on shallow trays 2 feet wide, 3 feet long, and 1 inch high, on which the grapes are allowed to sun dry, being turned from time to time by simply placing an empty tray top side down on the full one, then turning both over, and taking off the top tray. After the raisins are dried they are stored away in the sweat boxes until they are packed and prepared for shipment. Some of the larger growers, in order not to run so much risk in drying on account of rain, and also to enable them to handle the crop fast enough, have curing houses,

where the curing is finished after having been partially done outside. The seeding, grading, packing, and shipping have become separate branches.

The exports of California raisins first became of sufficient importance to be separately stated in the official reports of the Treasury department in the fiscal year ending June 30, 1892. Raisins have since been sent in small, it may be said experimental, quantities to all parts of the world, and the trade has grown until in 1898 the exports amounted to 3,109,-639 pounds, and in 1902 to 2,323,274 pounds.

The year 1894 was the record breaker, when 103 million pounds were produced. Raisin growers claim that this was made possible by the duty of 2 cents a pound on imported raisins. Consul Ridgely says, so cheaply and abundantly are raisins grown in Malaga, that were it not for the duty Malaga exporters would undoubtedly undersell California growers.

The manufacture of wine, brandy, and champagne from grapes constitutes an important industry in itself, and can not be described in this paper. According to the United States census for 1900, of the 179,055 gallons of sparkling wines manufactured, California reported 8,880; Ohio, 15,600; Missouri, 2,940; and New York, 113,435 gallons. This shows that New York produced more than twice as much as all the other states together.

The yearly production of wine from 1877 to 1891 in California was from 15 million to 20 million gallons, and the price fell below 10 cents a gallon, notwithstanding the fact that the demand had increased a million gallons annually; notwithstanding also that half a million gallons of brandy had been made in 1886, with the same amount in 1887, and, in the three years next succeeding, a million gallons annually; that in the southern part of the state 20,000 acres had been destroyed by the Anaheim disease; that in Napa and Sonoma counties the bulk of the vineyards were wholly or partially destroyed by the Phylloxera, and that about 600 carloads of dried grapes had been shipped in 1889 and 1891. The state of affairs then existing can hardly be imagined. Many growers became bankrupt; those who had sufficient means pulled up their vines and planted other fruits or raised hay and grain;

a few, who believed in the ultimate success of the industry, persevered, and replanted the vineyards which the Phylloxera had destroyed. In 1892 the heavy frost which prevailed over the leading wine districts cut the crop down to 15 million gallons, and prices went up. About this time the California Wine association was formed for mutual protection by the largest dealers. In 1894 the California Wine Makers' corporation was organized by the wine makers of the state for a similar purpose, and set the price in wholesale lots to the dealers at 15 cents. The corporation, which had secured enough of the state's output to control prices, entered into a contract by which an association of the principal dealers agreed to purchase from the corporation 5 million gallons annually. All went well until some of the producers became dealers and undersold the association. This resulted in a rupture of the two associations. At the next annual meeting of the members of the Wine Makers' corporation its board of directors was instructed to enter the markets of the world. A long war of cutting prices for standard wines was the result, which was embittered by the phenomenal yield of 1897 of 27 million gallons dry and 7 million gallons sweet wine, and prices again became low. The next season witnessed a great shortage in crop, only 18½ million gallons of both dry and sweet wines being produced. This led to better feeling between the factions, and brought about higher prices. Commercial statistics show that the trade requires 22 million gallons yearly—16 millions for export and 6 millions for coast consumption, 4 millions of this being sweet wine. The demand is increasing by 2 million gallons annually, so there is a shortage instead of overproduction, and the wines of 1900 changed hands at from 15 to 20 cents in wholesale lots from producer to dealer. The 1901 crop brought from 20 to 35 cents a gallon, and the price for the 1902 crop about the same.

This industry, which is not much more than fifty years old, gives employment to nearly 60,000 persons.

To the late Senator Leland Stanford, founder of the Leland Stanford Junior university, belonged the distinction of having the largest vineyard in the world, comprising nearly 5,000 acres, and being over 7 miles long. The wineries on

the place cover more than 6 acres of roof surface, and from $2\frac{1}{2}$ million to 3 million gallons of wine were made annually, from 400 to 850 tons of grapes being crushed daily.

At Asti the Italian-Swiss colony has 1,700 acres in bearing vineyards. On the place are extensive wineries, with the largest wine vat of the world, holding 500,000 gallons.

Near Cucamonga the Italian Vineyard company has, during the last three years, planted nearly 2,000 acres in one field. The Riverside Vineyard company during the same time planted 2,500 acres in one vineyard.

The California Wine association, at its own wineries, in a single year, worked up 150,000 tons of grapes and at its leased wineries enough more to make 225,000 tons. The association paid out in cash over $5,000,000 for grapes. Throughout the state there are quite a number of vineyards of 500 acres each.

New York being the leading state for the growing of American grapes and California for the Vinifera varieties, a brief review of the conditions and prices that have prevailed in those states will give a fair insight into the past history of the industry.

In New York thirty years ago 5 and 6 cents a pound were received for grapes. In 1889 the price per pound for basket lots was 3 cents, in 1893 about $1\frac{1}{3}$ cents, and 1898, 1899, and 1900 about three fourths of a cent, and in 1901 about $1\frac{1}{2}$ cents. In 1890 and 1891 bulk grapes brought an average of $20 a ton, and in 1892 an average of $18 per ton. From that time the price gradually diminished until 1896, when the average was no more than $9 a ton, and one particular lot of 100 tons was sold for $4 per ton. Since then the average price has been about $12 a ton until 1901. For some years the price of grapes failed to pay expenses of growing. The cultivation, or rather the care, of the vineyards had ceased to be a labor of love and had become one of necessity. The question was, Will the vineyards pay expenses then? In order to make them do so the vines were overcropped, expenses were curtailed, and each grower tried to do as much of the work as possible himself. Much of the work was carelessly done, much was left undone, and much was done at the wrong time,

resulting in injury to the vines from which they will never entirely recover. Such were the conditions at the beginning of the 1901 vintage, when on account of the great shortage of the grape crop in other sections and a short crop of other fruits, especially apples, with a lively demand for unfermented grape juice and cheap clarets, grapes were in great demand and much better prices were realized than for six years previous.

In California, in 1876, Mission grapes sold for from $7.50 to $10 per ton and other varieties from $14 to $18 per ton, so that many growers having poor shipping facilities turned hogs in to harvest the crop. In 1879 Mission grapes brought $10 to $12 and choice varieties $20 to $25 per ton. Prices then went up rapidly, and from 1880 to 1882 Mission grapes sold at from $15 to $20 per ton. The extreme prices had indeed been reached, and those growing grapes became rich in a few years. Everybody who could possibly plant an acre of vineyard did so, and in a few years the production far exceeded the demand, when prices dropped until in 1886 grapes brought only from $6 to $10 per ton.

After years of successes and reverses, shortages and overproductions, the industry in the east and west has gradually settled down to a more solid business basis. Grafting stocks are in good demand, the prices of grapes and wines are steadily increasing, and much new area is being planted in vines. The new plantings the last few years have been exceedingly large, and there is every indication that they will be even larger. It is to be regretted that in California, where so many thousands of acres have already been destroyed by the Phylloxera, many of those making new plantings are not using resistant stocks, and therefore many of the vineyards will not live long enough to bear a crop. In California, and the eastern section of the country as well, due regard is not being paid to the selection of the proper varieties of fruiting sorts, and returns will be diminished accordingly. This is especially to be regretted, for not only should growers, profiting by past experience, avoid errors previously made, but also improve methods wherever possible.

Looking back to the middle of the last century, when just a start had been made, when growers were beginning

to believe something might perhaps be done in the way of a commercial grape industry, and taking a glance at what such states as Virginia, Missouri, Ohio, New York, and California have done, especially New York and California, there is good reason to believe that the industry in this country may yet reach a development proportionate to that of other agricultural interests. The industry in the United States is as yet in its infancy. A beginning has just been made in a commercial and business like manner to improve the methods and expand markets. California has produced and sold annually the last ten years an average of 20 million gallons of wine, 2 million gallons of brandy, and 80 million pounds of raisins.

So far the raisin industry of this country has only supplied the small home demand of 80 million pounds, whereas the present population, were it to consume as much per capita as some other countries, say Great Britain, would now use 400 million pounds annually, not to say anything of extending the markets and exporting to other countries.

When it is considered that France in 1901 produced 1,523,233,200 gallons of wine, while this country produced 29,500,000 gallons, and that the golden state alone has a grape and wine producing area almost equal to the whole of France, some idea can be formed of the great possibilities of the industry.

A beginning has been made; what the industry will be remains largely with those who engage in it. No reason presents itself why varieties of grapes should not be cultivated wherever the wild vines flourish, and some of these are found in nearly all parts of the union.

Two important lines of work need thorough experimental investigation in the near future. One of these is the determination of the relative adaptability of resistant stocks to the various types of soil found in the commercial grape regions of the Pacific coast and of the congeniality of the leading commercial varieties of the Vinifera type to such stocks. The other is the development of varieties suitable for those districts east of the Rocky mountains in which the native grapes that have developed in New England, New York, and other

northern districts are not adapted to the climatic conditions. The field which is in special need of such varieties includes the south Atlantic and gulf states. With the wealth of native grapes in this region and the improvement of the grape already accomplished through hybridizing, it appears almost certain that varieties of choice quality, resistant to the fungous diseases that prey upon the Vinifera and Labrusca types in the south, may be developed, and in the not distant future make grape culture as remunerative and certain in its results in this region as it already is in other portions of the country.

AMERICAN WINE.

BY JOHN H. GARBER.

[John H. Garber, statistician; born Quaker City, O., December 14, 1866; educated in the public schools of that state, graduating from the Newark high school; superintendent of the Pella, Ia., public schools; chief examiner of the United States bureau of the census; expert special agent for alcoholic liquors and manufactures of tobacco, having charge of the gathering of statistics and the compilation thereof relating to these industries for the census bureau.]

Wine was manufactured before the dawn of history. The explanation of this is simple. It is the product of natural forces requiring neither mechanical powers nor manufacturing appliances. In the laboratory of earth and air, sugar is developed in the grape and in turn converted into alcohol. The vine and its fruit are as ancient and as widely distributed as the virgin forests of the earth. The accidental crushing of the grape and collecting of small quantities of its juice were followed by the discovery of its transformation and intoxicating properties after exposure to the air. Systematic observation followed close on accidental discovery, until chance gave way to design, and primitive wine making was ushered in.

The domestication of the vine and scientific methods of wine manufacture came many centuries later, and were among the first achievements of ancient husbandry. The time and labor required to plant and mature vineyards make them too valuable to be abandoned when once established. The cultivation of the vine was, therefore, incompatible with the pursuits of nomadic or seminomadic peoples, and the grape, like the olive, was, among the ancients, the symbol of settled and cultured life. The vine is especially susceptible to modification through culture or deterioration by transplantation, and while it is certain that the ancients cultivated many varieties, it is not possible to identify any of them with a modern botanical classification. The wines of Greece and Rome were highly flavored with spices and aromatic herbs, and in those countries viniculture attained its highest development in the vicinity of the Surrentine

hills and on the islands of the Ionian and Ægean seas. A detailed description of ancient methods of manufacture and the progress of viniculture westward with the movements of civilization to its installation and development in the modern wine provinces of Europe does not, however, fall within the scope of this article.

In that portion of the new world now within the boundaries of the United States, the native vines were distributed from ocean to ocean and from Michigan to Florida. Pre-Columbian adventurers from the north, driven by gales to the shores of the Atlantic, gave the name of Vinland to a portion of the coast; and all the American explorers after Columbus, at whatever point they touched the shore, or however far they penetrated the interior, found grapes in profusion and variety. The American colonists all came from countries in Europe where the manufacture of wine had for centuries been an important industry. It is true that viniculture in England had declined owing to the importation of French wines after the Norman conquest, but the English colonists were none the less familiar with the beverage and its uses. It is but natural, therefore, that the attention of the different colonies should have been early attracted to the cultivation of the native grape and its manufacture into wine as a possible source of revenue in the new country. Their hopes and expectations were greatly accentuated by the early writers, who gave florid descriptions of the abundance and luxuriance of the vines. In consequence, the efforts to introduce the culture of the grape for wine manufacture, made during our colonial period, were numerous, and common to all the settlements. Almost without exception, however, they were expensive and discouraging. In the more northern colonies the attempts were not long persevered in. This is particularly true of the colonies of New England. Massachusetts and her neighboring settlements had wild grapes, perhaps in as great abundance as Virginia, but interest in viniculture languished as the colony increased its exports of fish, lumber, and breadstuffs to the West Indies, Spain, Portugal, and the Wine Islands, receiving from those countries wines in reciprocal trade. In common

with all the other colonies those of the south failed in their efforts to introduce European varieties of grapes and failed also in attempts to domesticate the native vine. The work of caring for vineyards, particularly the dressing of vines in a way to secure best results, requires workmen of a high order of intelligence, the exercise of which was incompatible with the system of slavery under which the vignerons were at first compelled to toil.

After the failure to acclimate European vines it is not strange that colonial wine manufacture proved unprofitable, because the product of the native grape could not, as an article of export, compete with the products of other countries, perfected by the accumulated experience of centuries of wine making; and domestic consumption in a new country is always insufficient to create a profitable demand. Wine making is profitable only in an advanced state of society with accumulated riches for the gratification of luxurious tastes.

The first wine manufactured in the United States was made from the native wild grapes by the Spanish colonists in Florida, about 1565. An attempt at grape culture was made in Virginia in 1610, three years after the settlement of Jamestown, by Frenchmen who came to the colony to plant a vineyard. Later, about 1620, the London company sent French vineyardists to the colony for the same purpose. As far west as Kaskaskia, Ill., the French colonists in 1769 made wine from the wild grapes. In 1802 congress made grants on the Ohio river in Indiana to John J. Dufour, a native of Switzerland, who had been experimenting with foreign varieties of grapes near Lexington, Ky., and who represented a colony of Swiss emigrants, including several members of his own family. The colony settled at New Switzerland (now Vevay, Ind.) to engage in the planting of vineyards and the making of wine. These emigrants carried on the culture of the grape in a small way for a number of years, attaining moderate success with the Madeira and other foreign varieties, but a greater measure of success with the Schuylkill, an offspring of the native fox grape. In 1810 the settlement had 8 acres in vineyards and made 2,400

gallons of wine, valued at $6,000. In 1818, 5,000 gallons were made which sold at $1 a gallon, but the fact that this product was from small vineyards attached to separate farms would seem to indicate that the industry was being neglected for other lines of agriculture.

The first statistical reports of the United States government on wine manufacture are contained in the abstract of the census of 1810, compiled by Tench Coxe, and published at Philadelphia in 1814. From this abstract it appears that there were reported at the third census 14,191 distilleries, producing 22,977,167 gallons of spirits from fruit and grain and 2,827,625 gallons from molasses; 132 breweries making 182,690 barrels, or 5,754,735 gallons, of malt liquors, and wineries (number not mentioned) producing 11,755 gallons of wine, of which 9,230 gallons were made from currants and 2,525 from grapes. Of the total quantity of wine reported, 4,875 gallons were from Rhode Island, 4,480 from Pennsylvania, and 2,400 from Indiana. The Moravians had long carried on the manufacture of currant wine at Bethlehem, Pa., and Mr. Coxe in his report strongly urged its manufacture as being more profitable than that of grape wine. The total quantity of wine reported at the third census seems a small product after two hundred years of effort. It probably fell short of the real production, because it could not have included limited quantities made for home consumption from small and widely scattered vineyards attached to farms.

The first really successful attempt at wine making, and the one which might be regarded as the first of commercial importance, was made by Nicholas Longworth at Cincinnati, Ohio. He experimented first with vines procured from the Swiss settlement at Vevay, Ind., but later abandoned these for the Catawba, which he procured from John Adlum, of Georgetown, D. C. This particular variety of grape has played an important part in the development of the wine industry of the United States. In 1820 Mr. Adlum called the attention of congress to the fact that he had succeeded in making a superior quality of wine from the Catawba grape, and asked the use of certain public lands in the District of

Columbia for an experimental vineyard. His request was refused. Previously, in 1819, he had discovered a vine of the Catawba growing in the garden of an inn at Clarksburg, Md., and secured cuttings, which he planted in his vineyard on Rock Creek; and it was from him that Mr. Longworth, in 1825, secured cuttings for his vineyards at Cincinnati. This grape, when found by Mr. Adlum, was supposed to be a European variety, but is now thought to be a pure native. It was traced back to the Catawba river in North Carolina, from which it takes its name.

After the decline of the industry at Cincinnati, the cultivation of the Catawba was continued on the islands near the southern shore of Lake Erie. It is still cultivated there, and on the mainland in the vicinity of Sandusky, with considerable success. The greatest Catawba region at the present day, however, is the Keuka lake district in central New York, where the grapes ripen on the hillsides sloping down to the lake. In both the Ohio and New York districts this variety is largely used for the manufacture of American champagne. Mr. Longworth spent about forty years in trying to make American wine manufacture a success on the banks of the Ohio river, and at one time, about 1860, it was estimated that there were 2,000 acres in vineyards in the vicinity of Cincinnati. The decline of the industry in the Cincinnati district was due to the destruction of the vineyards by the black rot and the susceptibility to that disease of the varieties of grapes there cultivated.

Since the beginning of commercial wine manufacture, the states of New York and Ohio have maintained supremacy over the other states east of the Rocky mountains, except at the census of 1870, when the product of Missouri exceeded the combined product of both those states, and at the census of 1890 exceeded that of New York. At the census of 1860 the total value of the product for the United States was \$400,791; for New York, \$155,966; and for Ohio, \$47,275. At the census of 1870 the value for the United States was \$2,225,238; for Missouri, \$934,442; for New York, \$296,668; and for Ohio, \$309,375. At the census of 1880 the value for the United States was \$2,169,193; for Missouri, \$185,900;

for New York, $375,150; and for Ohio, $773,110. At the census of 1890 the value for the United States was $2,846,148; for Missouri, $244,300; for New York, $156,740; and for Ohio, $550,777. At the census of 1900 the value for the United States was $6,547,310; for Missouri, $199,130; for New York, $942,548; and for Ohio, $801,634.

East of the Rocky mountains the transplantation of European varieties of grapes for wine manufacture has not, to the present day, been attended with any measure of success. The Lake Erie district in Ohio, the lake districts of central New York, and the Hudson river valley are the only producing sections of real importance, and here the rigors of the climate are inimical to the success of foreign varieties. All the wine manufactured in these districts is from pure natives or from natural and artificial hybrids.

In the state of California wine manufacture has had a rapid growth. There, contrary to the universal experience east of the Rocky mountains, efforts to supplant indigenous vines by the acclimation of foreign varieties have been attended with a marked degree of success. Of the 23,425,567 gallons of wine reported at the census of 1900, 19,028,258 gallons were made in California. This is more than four times the combined output of all the other states, and practically all was made from European varieties, which have adapted themselves to their new environment. The introduction of the foreign vine into California dates back to 1771. It was brought from Spain by way of Mexico through the instrumentality of the Catholic missions. The mission of San Gabriel planted the first vineyard, and the planting of vines extended from mission to mission until vineyards comprising from 5 to 30 acres stretched from San Diego to Sonoma. The labor was performed by the native Indians, whom the Spaniards reduced to slavery and taught the elementary lessons of grape culture. The variety cultivated was what is now known as the Mission grape. It proved to be of lasting favor with the Spanish fathers, because its wine resembled somewhat the red wines of old Castile. All the missions grew this one variety, but with the characteristic susceptibility of the vine to soil and climatic con-

ditions the fruit took on various modifications in size, appearance, and flavor in the different localities where cultivated. For this reason, and because of different methods of treating the expressed juices, there was much variation in the general character and fineness of the wine. The Mission grape produced from 700 to 1,000 gallons of wine to the acre, and practically all was consumed in the neighborhood. There were no facilities for export; neither were there casks or bottles. For these reasons the industry can hardly be said to have reached the dignity of commercial importance, and its products were seldom seen in the marts of trade. The wine was fermented in cemented cisterns, where it was allowed to remain, or was drawn into hides or earthenware jars.

With the downfall of the Spanish power in Mexico the California missions waned, and with them viniculture declined also. In 1845 the missions were abolished and confiscated, and the Americans, when they came into possession, found both missions and vineyards in ruins. The concentrated interest of the people in the mining of gold, following its discovery in 1849, resulted in the neglect of agricultural pursuits, and grape growing and wine making remained undeveloped.

In 1856 statistics for the state showed approximately 1,500,000 vines, of which the Spanish settlement at Los Angeles had about 750,000. The others were scattered among the missions and Spanish ranches and were nurtured by irrigation. A. Haraszthy was the first to demonstrate the possibility of maturing grapes without irrigation by a system of stirring the soil around the roots of the vine. In 1858 he wrote an essay on vine planting and wine making which, with other literature on the subject, was given wide circulation by the State Agricultural society. This so stimulated interest in viniculture that by 1862 the standing committee of the legislature reported 20,000,000 vines planted throughout the state.

In 1861 a joint resolution of the legislature of California authorized and requested Governor Downey to appoint a commission to report "upon the ways and means best adapted to promote the improvement and growth of the

grapevine in California." Mr. Haraszthy, as a representative of this commission, visited the famous wine districts of Europe and purchased 100,000 vines, embracing about 1,400 different varieties, which were propagated at Sonoma. Cuttings from these vines were distributed among growers in different parts of the state. From that time the manufacture of wine in California has had a continuous and marvelous growth, interrupted only by the depreciation of prices through overproduction in certain years. In prolific seasons must has sold as low as 7 or 8 cents a gallon, which hardly equaled the cost of production. In 1860 the value of the product was $160,300; in 1870, $602,553; in 1880, $622,087; in 1890, $1,738,863; and in 1900, $3,937,871.

Since the introduction of European vines the product of California has included duplications, more or less perfect, of most of the well known varieties of European wines. California embraces nearly ten degrees of latitude. With the ocean on the west and the altitudes rising into the mountains on the east, with the hills, valleys, rivers, and slopes, the state has such a variety of soil, slope, elevation, temperature, and climatic conditions as to reproduce, somewhere within its borders, any wine now manufactured. At present, however, the dry wines have the characteristic heaviness common to the wines of all southern countries, where warmth and sunshine develop a large proportion of sugar in the grape, which in fermentation is transformed into an excess of alcohol. In time, however, through the discovery of new districts, the evolution of new varieties of grapes, the accumulated experience of vineyardists and wine makers, and the adaptability of consumers to the article consumed, California will resolve itself into wine districts, the products of which will be prized as those of the famous wine provinces of Europe.

According to the quantity of sugar retained by the arrest of fermentation, wines are divided into sweet and dry; according to color, into red and white; and according to the quantity of carbonic acid gas generated in fermentation and retained under pressure, into still and effervescing wines (champagnes). The quantity of sugar contained in grapes used for wine making is influenced by many con-

ditions, such as the variety of the grape, soil, climate, and the vicissitudes of the seasons, and will vary from 13 to 30 per cent. In fermentation sugar is converted into alcohol, and for the sweet wines the grapes rich in sugar content are chosen; before enough of the sugar is fermented out to convert the juice into a dry wine, some form of alcohol, preferably grape brandy, is added to give the requisite alcoholic strength and to arrest fermentation. Alcohol, by preventing further fermentation, fortifies against deterioration; hence the name fortified, applied to all classes of sweet wines. Such wines invite adulteration or a deviation from natural processes of manufacture. Sugar, alcohol, and water may be added to the juice to the point of sacrificing its characteristic flavor, which would insure detection. In all wines there is considerable sugar remaining after the first violent fermentation, and by natural process this ferments out slowly through a considerable period of time. The extent to which it is fermented out determines the degree of dryness, as wines shade easily into either classification. Usually, however, grapes lighter in sugar content are chosen for dry wines, because the desired dryness can be secured by the fermentation of less sugar, leaving the wine of less alcoholic strength.

Red wines are made from grapes with highly colored skins, which are fermented with the juice, and from which the alcohol, formed by the fermentation of the sugar, absorbs the coloring matter. The alcohol also takes up certain acids and other ingredients from skins and stems, which give the red wines a distinct physiological effect, principally through the astringent properties of tannin. White wines are usually made from distinct types of light colored grapes fermented without the skins.

Champagne is an effervescing wine, named from the province in France where it was first manufactured. Distinct types of grapes, as well as districts that will produce them, are necessary for its perfect production. The effervescence is due to carbonic acid gas generated in fermentation and retained under pressure. After the juice has passed through certain stages of fermentation it is bottled in heavy glass and tightly corked, the cork being bound in by wire

passed over the mouth and around the neck of the bottle. Fermentation continues and the gas generated is confined, producing a natural charging which, on the opening of the bottle, gives to the wine its effervescence. The manufacture of champagne entails great labor, time, and skill. About three years are necessary to perfect it, and all this time it requires constant care and handling; at different stages of the process it must be uncorked to expel sediment. There are all grades of champagne sold in the markets, from an inferior grade of wine artificially charged, to the wine of the highest type of grapes, perfected by natural processes.

Sweet and dry wines shade off into several types, rather than distinct classifications, and may be red or white, still or sparkling. These types take their names from provinces or from cities and towns in wine districts. Under these types are numerous brands named after valleys, villages, provinces, estates, or chateaux, or after some fanciful name of the producer. A modern first class hotel usually lists its wines under the headings of champagnes, clarets, Sauternes, Rhine wines, Burgundies, sherries, Madeiras, and ports. Champagnes are subdivided into foreign and domestic, and are classed as sweet, dry, and extra dry. Claret is a name given to dry reds or those of a general Bordeaux type; Sauternes, from a city near Bordeaux, are dry whites; Rhine wines are those from the wine districts of Germany along the Rhine river and are dry wines, usually white, but sometimes red; Burgundies, named from Burgundy, are dry wines, red or white, still or sparkling; sherries, from Xeres, Spain, are fortified wines, but, as some are much sweeter than others, they are designated as sweet or dry sherries, and are white or tinted still wines; Madeiras, after the island of Madeira, are much like sherries; ports, from Oporto, Portugal, are still wines, sweet, and usually red. Among the sweet wines, California manufactures large quantities of ports and sherries, and among the dry wines, clarets, and Sauternes.

TOBACCO.

BY JOHN H. GARBER.

[John H. Garber, statistician; born, Quaker City, O., December 14, 1866; educated in the public schools of that state, graduating from the Newark high school; superintendent of the Pella, Ia., public schools; chief examiner of the United States bureau of the census; expert special agent for alcoholic liquors and manufactures of tobacco, having charge of the gathering of statistics and the compilation thereof relating to these industries for the census bureau.]

The cultivation of tobacco and the use of its manufactures are of such antiquity that authentic history does not record their beginnings. The claims of certain European and Asiatic countries to an acquaintance with the plant prior to the discovery of America by Columbus are not supported by accepted history nor satisfactorily demonstrated by the researches of the antiquarian or the archæologist. It is fairly well settled that tobacco is indigenous to the western hemisphere, and that the aborigines practiced its cultivation and use from remotest times. Europeans learned its nature and effects from the American savage and spread the knowledge to the rest of the world. In November, 1492, two sailors sent by Columbus into the interior of Cuba returned with accounts of having seen the natives carrying firebrands and exhaling smoke from their mouths and nostrils. Investigation revealed that the firebrands were made from the leaves of tobacco, rolled and burned in a sheath of Indian corn, and that the smoke was inhaled for sensations of pleasure and exhilaration. The instrument used for inhaling the smoke was made from hollow cane forked in shape of the letter Y, the small ends being inserted into the nostrils and the large end applied to the burning leaves. The habit of snuff taking among the natives was described first by Roman Pane, a Franciscan, who accompanied Columbus on his second voyage, and the practice of tobacco chewing was first observed by Spaniards on the coast of South America in 1502. Tobacco was consumed in one form or another by the aborigines from Canada to Patagonia, and, especially in the form of smoking, its use was an immemorial custom.

Tobacco was first taken to Europe by Hernandez de Toledo, who introduced it into Spain and Portugal from Santo Domingo in 1559. In the same year it was introduced into France from the Spanish peninsula by Jean Nicot, the French ambassador at Lisbon. It is said to have been used in Italy as early as 1560. In 1585 it was carried to England by Sir Francis Drake and his companions on a return voyage from Virginia, and Sir Walter Raleigh introduced among the Elizabethan courtiers the fashion of pipe smoking, which spread through England with great rapidity. In 1610 smoking is known to have been practiced as far east as Constantinople. Tobacco was cultivated in Holland in 1615, and in 1620 smoking was introduced into Germany. In 1631 the use of tobacco began in Austria, where it was carried by Swedish troops, and in 1653 it is known to have been used in Switzerland. In a period of three hundred years tobacco has circled the earth on practically every parallel within the limits of civilization. It is known everywhere, except among a few barbaric peoples in inaccessible countries, and exceeds every other narcotic in the universality of its use. It is probably exceeded only by salt in width of distribution and cosmopolitan consumption. The adaptability of the plant to varying climatic conditions has been an important factor in its dissemination. While it responds, to the extent of pronounced modifications, to the varying influences of soil, climate, and methods of cultivation, its essential characteristics will develop in the cold climate of Canada or on the arid plains of Java. Certain districts produce tobacco having distinct characteristics just as certain provinces produce varieties of grapes that make distinct types of wine. Great diversity of taste is also shown among the people of different nations, in their demand for the different types of tobacco grown in various parts of the world, and it is natural, therefore, that the commodity should become one of importance in international trade. In foreign countries its cultivation and manufacture are frequently made government monopolies, and in some its cultivation is prohibited.

The first tobacco cultivated by a European within the present limits of the United States was grown by John Rolfe

at Jamestown, Va., in 1612, five years after the settlement of the colony. As early as 1615 the fields, gardens, streets, and public squares of Jamestown were planted with tobacco. It was the one commodity which sustained the struggling settlement, because it readily commanded, in reciprocal trade with the mother country, the necessaries of life. It was the medium of exchange and the standard of value. In 1619, 20,000 pounds were shipped to England. The profits were so satisfactory to the growers that even the cultivation of food crops was neglected for that of tobacco, and it was restricted for a time by legislative enactment. In 1621, 60,000 pounds were grown, of which 55,000 pounds were exported to Holland, the shipments being diverted to that country because of the excise levied by England. In England the legislation of the Stuarts and that of Cromwell were alike in opposition to the use of tobacco, and it was almost completely stamped out by the protectorate. With the restoration, however, it reappeared, and its consumption has since increased steadily with every year.

In 1731 the combined exports of Virginia and Maryland were 36,000,000 pounds. From 1763 to 1770, the average annual exports from all the colonies amounted to 66,780,000, pounds, and for the four years immediately preceding the revolution the average quantity annually exported was 100,000,000 pounds. During the revolutionary struggle the exports dropped to an average of 12,000,000 pounds annually.

The settlers of a new country take with them the customs and pursuits of the old, and the Virginians who settled Kentucky early introduced into the new territory the cultivation of tobacco, which was grown as a commodity in parts of Kentucky and Tennessee as early as 1810 and, prior to 1833, was shipped by boat to New Orleans, where it was purchased for foreign consumption. As the production increased, factories were established for purchasing loose tobacco and stemming it for the English market. The first inspection warehouses in the United States had been established in Virginia in 1730. In 1839 similar warehouses were established at Louisville, Ky., and in 1845, at Clarksville, Tenn. With the introduction of such local markets the tobacco trade of the

Mississippi valley developed with considerable rapidity, but always with precision.

In New England some tobacco was grown in the decade ending with 1650, but its cultivation was abandoned until the beginning of the nineteenth century, when it gradually revived. By 1825 the crop was such as to encourage the establishment of a warehouse at Warehouse Point, Connecticut. About 1833 it was ascertained that a variety, possessing in remarkable degree the fineness of texture, strength of tissue, and smoothness of surface, so desirable for cigar wrappings, could be grown successfully in Connecticut, and the census returns since 1840 show an uninterrupted increase in its cultivation in that state, except at the census of 1890. This single interruption is explained by the influence of legislative enactments affecting the tariff on imported leaf suitable for cigar wrappers. The profits of the industry in Connecticut stimulated the cultivation of tobacco in eastern Pennsylvania, central New York, and later in the Miami valley of Ohio, and in southern Wisconsin. In 1900 the combined production of Connecticut, Pennsylvania, New York, Ohio, and Wisconsin was 183,849,340 pounds. In 1904 for the same states the product amounted to 149,598,003 pounds.

Of the 5,739,657 farms in the United States, 308,317, or 5.4 per cent, reported the cultivation of tobacco in 1899. These farms cultivated an average area of 3.6 acres of tobacco producing 788 pounds per acre, valued at $0.07 per pound, $51.74 per acre, and $185 per farm. Tobacco brought to its growers an income per acre of more than five times that derived from all other crops, which was $10.04, and over six times that obtained from cereals, which was $8.02. It yielded nearly two and one half times the average income derived from rice, and considerably more than that reported for vegetables, which was $42.09. No crop presents in its statistics, by states and territories and by counties, so many variations and sharp contrasts, and none varies so much in its market prices, the price of tobacco at the present time ranging from $0.02 or $0.03 to $2 a pound.

At the beginning of the last half of the nineteenth century Virginia led in the production of tobacco, reporting, in 1850,

28.4 per cent of the total crop. It held first position until after the close of the civil war and the division of the state, when it fell to second place, Kentucky assuming the leadership. The 11 leading states in acreage in 1899 were also the 11 principal states with respect to production. They are arranged, however, in a slightly different order. Ohio is fifth in acreage, but fourth in production. Tennessee reverses this position. Maryland was sixth in acreage and eighth in production; Wisconsin, seventh in acreage but sixth in production; Pennsylvania, eighth in acreage and seventh in production; Connecticut was eleventh in acreage but tenth in production, changing places with New York, which was tenth in acreage and eleventh in production.

Especially in the states of the north, every town of any considerable size has its local cigar factory supplying in part the local demand and extending its trade to neighboring villages and towns in proportion to the aggressiveness of the manufacturer and his ability to succeed against competition. The material used in these local factories consists of small lots of leaf tobacco varying in character, quality, and cost according to the quality of the cigars to be made and according as the material is intended for fillers, binders, or wrappers. Such material is usually purchased from importers, wholesalers, or rehandlers, and in such limited quantities as to be quickly worked up and realized on in the local marts. The live capital involved is, therefore, not necessarily large even in proportion to the magnitude of the business. The selection, preparation, and apportionment of the filler, the cutting of the binders and wrappers, and the binding and wrapping are all done by hand. After binding, the unfinished cigars are usually placed in forms or molds and left for some hours in hand presses until the desired shape has become fixed, when they are ready for wrapping. When wrapped, the cigars are assorted into lots having the same shade, and boxed for sale. The work is usually done in rented rooms, and no capital, as defined by the census office, is involved in land and buildings. A set of molds and a hand press constitute the principal equipment. In contradistinction to this class of establishments, is the large factory, representative of the purely

commercial aspect of the industry, housed in a large building whose architecture is typical of the modern factory, located usually in a large city, equipped with modern and expensive machinery, employing thousands of wage earners, and manufacturing millions of cigars and cigarettes annually.

The first cigars consumed in the United States were imported, but the exact date of the first importation is not known because it was included in miscellaneous merchandise. The separate tabulation of imported cigars was begun in 1804, in which year 4,001,000 were received, principally from the West Indies. The first cigar manufactories in the United States were established in Connecticut in 1810, but it is believed that the household manufacture of cigars had been carried on in the Connecticut valley for several years prior to that date. After the first factories were established at East Windsor and Suffield, Conn., the industry gradually spread through the state and into the other states of the New England group.

Kentucky followed Connecticut in the establishment of cigar factories. As early as 1816 a factory is said to have been established at Maysville. The industry gradually diffused through the state and into Ohio and Tennessee. In 1825 comparatively small factories were found more or less widely scattered through New York and Pennsylvania, and by 1840 factories in considerable number were in operation in New York, Pennsylvania, Maryland, and Virginia. The first cigars made in the United States were almost exclusively the product of domestic leaf, but the importation of Cuban tobacco began early in the history of the industry, and by 1847 had assumed such proportions as to be tabulated in the customs returns. The early manufacturers in the United States had to contend against the importation of cheap cigars from Germany, where their manufacture and consumption date from 1796. The tariff acts of 1861, 1862, and 1864 prevented the importation of the German product, and in consequence the industry in the United States received such an impetus that it has continued in practically uninterrupted growth to the present time. The first internal revenue law laying a tax on cigars and other forms of manufactured tobacco, was passed to meet in part the exigencies of the civil war, and took effect

July 1, 1862. By this act the revenue tax on cigars varied from $1.50 to $3.50 per thousand, according to value. The organization of the bureau of international revenue for the collection of taxes under the elaborate system of excise, dates from the act of 1862, and statistics of all forms of tobacco since that time are more complete and reliable than formerly. No very large factories were in existence prior to 1870. In the decade ending with 1880, however, extraordinary prosperity attended the industry; the first large manufactories were then established and commercial cigar manufacture was outlined and became fixed.

Within the last few years both the cigar and the cigarette manufacture have been revolutionized by machinery. As cigar making is widely diffused in the form of numerous small establishments in which the work is done by hand, the utilization of modern machinery in the manufacture of cigars is not as general as in that of cigarettes, which is concentrated in large factories. Four cities, namely, New York, N. Y.; Richmond, Va.; Durham, N. C.; and Rochester, N. Y., produce about 94 per cent of all the cigarettes manufactured in the United States, and practically all are machine made. Considering the large number of very small cigar factories in the United States, comparatively few establishments of this class are sufficiently large to make a complete equipment of modern machinery a paying investment. Taking the largest factories, however, as representative of the application of modern machinery to the industry, it is a fact that both cigar and cigarette manufacturers are utilizing some of the greatest contributions of genius to the lessening of the world's work. Everything, from the stemming of the leaf to the payment of wages to the employees of the factory, is done by machinery. In a modern cigarette factory the prepared tobacco and the sheets of paper used for wrappings are fed to machines which cut the paper into proper size for the wrapper, gum its edge, measure the exact quantity of tobacco needed for each cigarette, wrap it, make the edges of the wrapper adhere, cut the ends, and pack the cigarettes in boxes. In the manufacture of cigars, the prepared filler is placed in the hopper of a machine which apportions the quantity nec-

essary for each cigar, places it in the binder spread to receive it by the operator of the machine, and rolls it. The wrapper is substantially added by hand or by machinery.

In the last quarter century the manufacture and consumption of cigarettes in the United States have grown with marvelous rapidity. In 1875, approximately 40 millions, and in 1900, 3,260 millions were consumed, an increase of more than eightyfold in twenty five years. Much of the popularity of cigarette smoking has its origin in business and social conditions which evolve and govern habits of living. For many years there has been an increasing demand for tobacco in a form that affords a short, inexpensive smoke, producing immediate effects. The cigarette is made from a specially mild tobacco, and the consumer almost invariably inhales the smoke, which comes in contact with the delicate membranes of the respiratory tract. In this way the active principle of the tobacco is quickly taken into the circulation, producing immediate physiological results. The tobacco selected is usually of a very light shade, which comes from the variety of the plant, the district in which it is grown, and methods of curing, or all these in combination. Secret processes of bleaching are said to be used by some manufacturers. Harshness may sometimes be subdued into desired mildness by dipping or soaking the tobacco in water slightly acidulated with hydrochloric acid. The selecting, blending, saucing, and general methods of treatment are in accordance with the secret formula of each establishment.

The crude hand manufacture of chewing and smoking tobacco and snuff from the natural and unflavored leaf has grown to the modern manufacture of a multitude of forms, which are the products of elaborate systems of selection, blending, fermentation, flavoring, and saucing, designed to satisfy the tastes of the various classes of consumers. As to form, there are two general classes of smoking tobacco put upon the market, namely, the granulated or flake, and the cut or shredded forms. The former is produced by granulating machines of different styles and varying capacity, in which the breaking and sifting principles predominate. The latter class is produced by feeding the prepared tobacco, flavored

and gummed, into machines which first compress it and, in turn, feed it to rotating or vertically reciprocating knives, which shred it to any desired fineness; it is then dried and bulked, after which it is packed in paper, foil, cloth, tin, or glass packages in a multitude of sizes and styles.

The cost of producing smoking tobacco has been greatly lessened within the last few years by the invention and introduction into the large factories of ingeniously constructed machinery to do the packing. The prepared tobacco and the paper in which it is to be wrapped are fed to a machine simultaneously; the result is a neatly wrapped package ready for the shelves of the retailers. Between thirty and forty thousand packages are turned out by a single machine in a day of ten hours. A form of smoking tobacco known as cut plug is popular with a large class of consumers. It is a form of shredded tobacco, but made more compact by greater pressure. After the leaf is prepared (sauced and gummed) it is pressed into cakes of desired thickness by hydraulic or steam power presses. The cakes are then cut into plugs of desired width by machines not unlike those used in paper mills for cutting paper. The plugs are next run through machines with vertically reciprocating knives which cut them into transverse sections ready for packing in layers in tin boxes.

The manufacture of plug chewing tobacco is, compared with that of other forms, a simple process. After the preparation of the filler, it is pressed by hydraulic or steam power into cakes or plugs of varying width, length, thickness, and style, after which it is wrapped and boxed. Fine cut chewing tobacco is made by machinery very similar to that employed in manufacturing smoking tobacco, the leaf being cut into much finer shreds and sauced or cased according to the different formulæ of different establishments.

The making of snuff is the most complicated of all the processes of tobacco manufacture. This article, as found on the market, may be roughly divided into two classes, namely, dry and moist, each of which varies greatly in quality. Snuff is sometimes manufactured in connection with cigars and chewing tobacco, as it affords an opportunity to utilize the

parts of the leaf not consumed in those products. The material for dry snuffs is first dampened and put through cutting machines, which chop it finely. It is then subjected to a high temperature and rendered perfectly dry, when it is ready for grinding. The grinding machines preserve much of the principle governing the first manufacture of snuff, which was reduced to a rough powder by pounding or grating. The commonest form of grinding machine consists of a receptacle shaped like the frustum of a cone inverted. A set of rollers of corresponding inclination revolve close to the inner surface, grinding the tobacco between to a fine powder. The finished article is packed by machine packers into bladders, tin cans, earthenware jars, glass tumblers, etc. Scotch, Irish, and Welsh snuffs are the commonest forms of the dry class.

Moist snuffs are of infinite variety. The material used in their manufacture is moist when ground, and is not reduced to a fine powder like the dry snuffs. After grinding, the flour is subjected to as many different processes and manipulations as there are manufacturers. Many of these involve frequent handling and bulking to control the different stages of sweating or fermentation which give character to the finished article, darkening it and developing its peculiar flavor. In addition to saucing, fermentation, and manipulation, ingredients are added to flavor and perfume.

The largest tobacco factories are gathering under one roof the manufacture of practically everything that contributes to the tobacco industry. Factories are now fully equipped for manufacturing the tin, paper, cloth, and other packages in which the products are packed for market, as well as boxes or cases in which they are shipped. Equipment for printing and lithographing labels and advertising posters is also an adjunct of a modern factory, so that there is little demand to be supplied by outside establishments.

RICE.

BY DANIEL C. ROPER.

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If its importance as a food product is to be measured by the number of persons who consume it, rice must, without doubt, be considered the greatest cereal. The countries in which rice forms the principal and, very often, the only food, have a population variously estimated to be from 825,000,000 to 900,000,000 of the world's population of nearly a billion and a half. There is no authentic record of its origin, though frequent mention is made of it in ancient literature. Nearly all authorities agree, however, that the Chinese were its first cultivators.

It was introduced, for cultivation, into the United States in 1647, when Sir William Berkeley, then governor of Virginia, received a half bushel of the grain from England. He caused this to be planted and from it a yield of 16 bushels was obtained. But with this the industry appears to have rested until 1694. In that year a ship bound from Madagascar was obliged to seek refuge in the harbor at Charleston, S. C., owing to a violent storm at sea. The captain of the vessel finding an old friend, Thomas Smith, governor of the province, presented him with a sack of the grain. Experiments in its cultivation were begun, resulting in making South Carolina, for more than a century, the leading rice producing state of this country.

Up to 1860 the industry was confined chiefly to the Carolinas and Georgia, these states producing practically the entire commercial crop. But the revolution in the systems of labor, and the almost complete annihilation of the capital of the planters by the Civil war resulted in a new beginning for this

industry, which brought radical changes in farming methods and in milling processes.

The effect of the change in labor conditions, resulting from the war, has been instrumental in keeping rice production practically at a standstill in the two Carolinas and Georgia, and to increase its culture on the prairie lands of Louisiana, where improved machinery can be more advantageously employed. For example, the combined production of the Carolinas and Georgia decreased from 56,641,486 pounds in 1869 to 50,741,787 pounds in 1889, while that of Louisiana increased from 15,854,012 to 75,645,433 pounds during the same period. The twelfth census, reporting for the crop of 1899, gives the Carolinas and Georgia 66,427,270 and Louisiana 172,732,430 pounds. The remarkable increase in rice culture in Louisiana and Texas during the past decade is due to the discovery that the lands of this region are both suitable to rice culture and capable of satisfactory irrigation. The farmers no longer raise Providence rice, a localism for a crop dependent upon rainfall, but the rivers and bayous have been utilized and canal companies have grown rich furnishing water to rice planters. When the flooding season is over, these lands are so readily and thoroughly drained as to permit of the employment of modern harvesting machines.

With the opening up of these vast prairies to rice culture have come the gang plow, the horse drill, the twine binder, and the steam thrasher. One harvesting machine, operated by one man and five mules, does in one day what formerly required a whole family and hired help to do in a season. Nowhere else in the rice growing belt has it been possible to introduce such implements, owing to the inability of the growers to properly drain their rice lands.

The problem of a fuel supply has been removed by the recent discovery of natural oil in Texas. Beaumont, the famous oil center, is in the midst of this rice belt. Oil tanks already dot this section, and rice farmers and rice millers alike are using the oil for fuel. There has thus been made available for rice culture in southwest Louisiana and southeast Texas a vast territory which will guarantee a steady increase of the rice crop, unaffected by drought and so cheap-

ened by the utilization of machinery as to encourage the hope that the United States may at no distant time not only supply its own consumption requirements but successfully compete with the east in the markets of the world.

Although rice is one of the oldest cereals and constitutes the principal food of over half the people of the world, the methods of cleaning it have until recently been of very crude design. The great advancement in the methods of recent years is largely the result of greatly increased production and consumption among the civilized countries and the technical requirements of a fanciful trade.

The primitive method of milling rice in the United States, and at present in vogue in China and other foreign countries, is to place a small quantity of the grain in a hollow stone or block of wood and pound it with a stone pestle. The blow cracks the hull, and the friction created by the sliding motion of the rice under the pestle removes the hull from the cuticle. The hulls and bran are gotten rid of by winnowing. The first advance from this process was the use of a mortar made of a short section of a hollowed log, the pestle being a heavy pounder attached to a horizontal beam 6 to 8 feet long, which rested upon a fulcrum, 4 to 5 feet from the mortar. The pounder was raised and dropped by quickly stepping on and off the shorter end of the beam. This simple process and the fanning mill are in use in Oriental countries at this time. Such a mill cleans about 11 bushels of paddy a day. The next advance was the use of the water wheel as a motive power, geared to a horizontal shaft. The pounder was a vertical beam, about 10 feet long and 6 inches square. As the horizontal shaft revolved, a rounded arm projecting from it caught a pointed pin in the vertical shaft, raised the pounder, and slipping past dropped it into the mortar of rice. This was repeated until the hulls and bran were separated from the grain.

The usual process of milling the rice of commerce is more complicated. The paddy is first screened to remove trash and other foreign particles. The hulls are then removed by rapidly revolving millstones, and separated from the whole and broken rice by means of screens and blowers.

This process does not remove the thin cuticle of the grain; to do this it is passed through a huller or subjected to heavy pounding. The huller is a short, horizontal tube of cast iron, with interior ribs and a funnel at one end to admit the rice. Within this tube revolves a shaft, with ribs so adjusted that the revolution of the shaft creates sufficient friction to remove the cuticle. The rice passes out of the huller at the end opposite the funnel, to be separated from the by-products and polished. In other mills the cuticle is removed by pounding in mortars, with pestles weighing from 380 to 400 pounds. Strange to say, this heavy weight breaks comparatively few grains. When it is sufficiently cleaned, the flour and bran are separated, and the grain sent to cooling pans, where it remains for eight or nine hours. After passing through the huller or the mortar, the rice is ready for the finishing process, polishing, which gives it a pearly luster. This finish is secured by passing the whole grains through a rapidly revolving screen with brushes, or with wire gauze and sheepskin.

This process gives to the rice grain its fine, glossy surface, and adds to its commercial value, but detracts from its value as a food. The outer surface of the clean, unpolished rice contains almost all the fats of the grain, and its removal materially lessens both the flavor and nutritive value. The fashion of highly polishing the grain for the general trade does not tend to popularize it as a food. In its preparation for local consumption rice is seldom or never polished. This may explain the reason why travelers remark upon the excellent quality of Oriental rice compared with that of commerce.

The grading of clean rice is not according to quality. From one kind of paddy may be obtained several grades according to the size of the grain, whole or broken, its susceptibility to polish, and general appearance. The average price for the crop of 1899 varied from $2\frac{1}{2}$ cents per pound for common, to 6 cents for fancy grades. No. 2 rice, consisting of broken grains and fragments, and worth about $1\frac{5}{8}$ cents per pound, is mostly used by breweries, and therefore called brewers' rice. This arbitrary grading of rice according to size and luster, without regard to quality,

makes breakage in milling a serious problem for both producer and miller. When a grain breaks it loses a large percentage of its commercial value, though its food value is unchanged. Rice worth 6½ cents as extra fancy, when broken so as to pass through a No. 12 sieve, is worth only 1½ cents.

The proportion of whole rice obtained by milling varies greatly, dependent largely upon the quality of the paddy. The selection of seed, cultivation, and curing all decidedly affect the friability of the grain. Careful attention on the part of the planter goes further to decrease the percentage of broken rice than that of the miller himself. The annual loss in the commercial value of the rice crop, on account of the difference in price between whole and broken rice, has been estimated by the United States department of agriculture at about $2,000,000. The most productive is not usually the best milling rice.

AMERICAN TEA GARDENS.

BY GRACE RILEY CLARKE.

[Grace Riley Clarke, author; born in New York; educated in the public schools of Ohio; became a teacher in the public schools of Newark, O., and taught until her marriage to Byron E. Clarke of Chicago; since her marriage has been engaged in literary work contributing articles to newspapers and magazines, her special field being the economic aspects of woman's employment in modern industry.]

Perhaps it is enough to deduce from the evidences of American tea culture up to date that this country soon will produce practically all of the $15,000,000 worth of tea consumed here annually.

To consider the home tea product in the light of an export, which, though small in comparison, one day will take its place with the great American staples, seems at this stage superfluous. The fact, however, that the journals of Ceylon and other foreign markets already print items about our growing tea industry points significantly to its importance. Further, one of the many who believe in both the producing and exporting possibilities for American tea has suggested that the skeptic turn to the history of cotton in the south.

The handful of seed that was sown in a Virginia garden and carried thence, after many unsuccessful generations, to the Carolina and Georgia plantations, was even there scorned in the light of wealth that already was being got out of tobacco, indigo, rice, and the silk mulberry. To this it might be added that those who have the gift of prescience which comes of putting together the past and the present see ultimate success for the tea industry in the pertinacity with which partially successful experiments have been returned to time and again.

One day, a century ago, Michaux, the French botanist, set out a tiny tea shoot, which flourishes yet as a tree fifteen feet high at Middleton barony on the banks of the Ashley river. Ever since then the United States agricultural records have narrated attempts at tea growing. As long ago as 1848

the fact that it could be grown successfully in this country was demonstrated at Greenville, S. C., but the planting was soon abandoned.

Nothing further was accomplished until 1881, when the government took it up as an experiment in a portion of the old Newington plantation at Summerville, S. C. This project came to an untimely end through the retirement from office of Commissioner William G. Le Duc, who was responsible for it, and the death of Mr. John Jackson, the manager. There followed the report of Commissioner George B. Loring, which stated that the climate was unfavorable.

Then appeared Dr. Charles Shepard, who not only believed that the half completed experiment pointed to the success of the industry but who had also a strong enough motive in his hope of establishing employment for many thousands of the southern population, to devote both his money and his brains to its development.

It was a little over thirteen years ago that he established his first garden at Parkhurst, a mile away from the abandoned government garden of Summerville. It is the record of what he has accomplished there with government help that has demonstrated the commercial value of the enterprise, although several other gardens have sprung up in the southern states lately. Incidentally these may be taken as a recognition of the unmistakable conditions of success which have the last few years developed with great rapidity at the Pinehurst industry. Briefly these are:

The steady increase of production, not only in quantity but in the amount of yield per acre.

The fact that the cost of production has reached a point where it is less than 25 per cent of the retail price which can be maintained.

The increasing demand for the tea, which now has a ready sale from Massachusetts to Florida, and also in the central and western states, and which grows faster than the gardens expand.

In addition to these favorable general conditions is the specific fact that much of the ground planted of late has yielded an average profit of $70 per acre, while considerably

less than this is not considered bad farming in that region. It is also significant that the conditions producing the profit are the result of treatment of the soil chemically, and also of a plan of applying certain seed to certain conditions, both of which can be repeated scientifically.

Basing a calculation of profits upon a production of only 400 pounds per acre, which yields $40 net as the lowest estimate, the possibilities may be seen in the fact that the latest crops have doubled those of the years preceding on account of certain definite experiments undertaken toward the end. The most conservative prediction of the result of still further treatment in the same line points to the increase of production to 1,000 pounds per acre, or the same as the annual yield of many plantations in Ceylon. This, it is believed, can be depended upon except during a year when it is unusually cold for that region.

Climatic and other opposing conditions are such, however, that the would-be tea grower needs to become thoroughly conversant not only with the science and practice of the whole culture but with its adaptation to this country.

One of the things which has always been considered necessary to success is an annual rainfall of from 80 to 120 inches, while in many parts of this section it averages only 56 inches. Oriental authorities have also believed that, while the plant would grow, it would not thrive to become productive in a temperature that ever dropped below 40° F. At Pinehurst 15° F. is expected every winter, while within the last few years it has once fallen to a half degree below zero.

The fact that the plants stood this severe cold, with no greater setback than a low pruning, which retarded growth to about the same extent as the customary pruning which takes place every four or five years in India and Ceylon, was taken as an encouraging sign. After this Dr. Shepard followed even more persistently than before the plan of obtaining at whatever expense the hardiest varieties of seed. Those especially of teas grown at high altitudes have been sought, and of all tried the Darjeerling seed has proved to be best adapted to the climate and at the same time the most productive.

A system of soil treatment was devised. To compensate for the scarcity and unequal distribution of rainfall, a rich soil is necessary, for tea flourishes best in the mold soil of valleys. The analysis of the best Indian tea soils shows a great deficiency of lime, an absence of sulphuric acid, plenty of manganese, with good amounts of nitrogen and potash. Pinehurst experiments have been conducted on sandy, clayey, and bottom lands, and on level ground, hillsides and drained ponds. The conclusion reached is that level lands thoroughly drained, porous to as great a depth as possible, and free from acidity will produce the best results.

For their treatment, Dr. Shepard followed underdraining, with deep plowing, and pulverizing, with chemical fertilizers which supplied the elements lacking, and with a careful system of surface cultivation which lessens the evaporation of moisture.

The gain thus made is equal to fifteen inches of rainfall. The good effect is further enhanced by planting between the bushes cowpeas, whose roots penetrate the soil, and dying, not only act as a fertilizer, but make the earth more porous and capable of retaining moisture during the dry seasons. Another thing evolved is a system of pruning, which increases the breadth rather than height of the plant, and conserves strength so that pluckings shall be more frequent.

This care in cultivation has already effected a productiveness which averages greater than that of China and Japan, and which approaches that of Ceylon. By a greater increase it is designed to still further offset the cost of labor.

The American planter has to compete with coolie labor by paying pickers from 30 to 50 cents a day, or from six to eight times as much per pound as the price paid in the east. This fact has always been considered the greatest obstacle to the industry in America. That the amount of productiveness already obtained has offset this expense so that a desirable profit results has been shown.

This profit has been made, however, from manufacturing one grade of tea. It is a black tea, which retails for $1 a pound. Green teas have been manufactured to some

extent also, but the possibility of substituting machinery for hand labor in making black tea has led to its being the chief staple. "With the lower grades of tea," says Dr. Shepard, " it is impossible to compete with Asiatic products, even with the utmost economy."

There are, therefore, two alternatives presented to the would-be American tea grower. He must raise the quality of his product above that of the cheaper Oriental grades, or he must reduce the cost of production.

The former plan has been maintained at Pinehurst with promising results, by aiming to avoid the raspiness and extra degree of pungency which many tea drinkers conceive to be the strength and value of tea. "This is really due," says Dr. Shepard, "to tannic acid and similar substances, which are deleterious rather than nerve strengthening. A tea may be rich in this last property and yet not exhibit much color, nor provoke throat irritation, nor act injuriously upon the digestion."

Something which has lately contributed to a smaller cost of production is the substitution of machinery for hand labor. The black tea is now made altogether by machinery, although as yet there are processes in the green tea that are only possible by hand. Experiments are being made constantly along this line, with the hope of introducing machinery which will greatly lessen the cost of producing.

There is a field open to the tea grower which has already been experimented with, and which offers a limited field for large profits. This is to make high priced teas, which are rarely seen outside the countries where they are grown. "The best Oriental teas," says Dr. Shepard, "are only slightly fired—that is, they are dried at low temperature, to preserve certain volatile oils which give them delicacy of flavor. They will not bear distant transportation, as they do not keep their qualities for a long period.

"Such teas are worth from $5 to $20 a pound in Japan and China, whereas the bulk of teas that we import from those countries cost less than 15 cents a pound at the port of shipment. Twenty dollars a pound for tea means a dime or less for a cup of this beverage. But the price, strange as it may

sound, in this country could not prove a barrier to a grade of tea which would otherwise prove unattainable. It is a profitable, if limited field, because there can be no competition from afar."

A calculation of the outlay necessary in beginning the manufacture of the moderate priced tea may be based on the description of the process in use at Parkhurst.

The first step is the withering of the fresh leaf. This is done by thinly spreading out the leaf on floors or trays, so that every pound shall cover about ten square feet. An expensive item is the space required for this, as every pound of finished tea represents four and a half pounds of fresh leaf, so that an output of 100 pounds of dry tea requires about 4,000 square feet of withering surface.

The purpose of withering is to render the fresh leaf susceptible to rolling without breaking. This requires a light, airy room, but it is better to exclude direct sunlight. A few hours sometimes suffices for the change, but usually a whole day's exposure is necessary. When sufficiently withered, the leaf is rolled, either by hand or machine, to press the juice out on the surface. It then becomes foamy from the action of the air. Oxidation begins and by continuing this and the rolling the strength and flavor of the tea are developed. The rest of the flavor and the fragrance are the result of the final process of firing or drying.

It is by putting in machinery for most of these operations that profits have been derived at Parkhurst. In the rolling of tea leaf a man can handle thirty pounds a day. A rolling machine can do as much in half an hour with the help of a mule.

The total cost of a factory suitable for the daily production of fifty pounds of dried tea may be estimated at from \$1,500 to \$2,000. The loss which comes from the impairment of good seed in the long journey from the east, whereby only one box in four comes to hand in good order, should be added, as must the remuneration of the skill and attention of those who must patiently oversee every step in the growth and manufacture of the product.

One feature in the cultivation of tea to which attention is called, and which has an interest for the planter, is that the

season for gathering lasts six months. Thus a crop is independent of the weather of any one or two months. Another point is that returns may be expected after the space of two years, which is more than can be looked for in an orange grove or a peach orchard. Still another thing worth noting is that what has been accomplished has been done in the absence of a duty on tea, which is a condition unprecedented in countries with tea growing interests, even England having a protection on this product of her Indian colonies.

THE GROWTH AND HANDLING OF SEEDS.

BY A. J. PIETERS.

[Adrian John Pieters, botanist; born Alto, Wis., November 18, 1866; graduated University of Michigan, 1894; took special studies in botany; botanist in charge of seed and plant introduction and distribution U. S. Department of Agriculture since July 1, 1902; is recognized as the leading authority in this line and has done more than any other man to apply botanical science to the needs of the farmer.]

It is a little more than a hundred years since the United States imported any considerable quantity of red clover seed. For many years before that, grain, clover, and grass seeds had been gathered and sold in the colonies, but much had always been imported. This condition was reversed soon after the opening of the nineteenth century, and from that time the amount of seed raised in America for home consumption and for export has steadily increased, until to-day Europe looks to the American farmer for a large part of her supply of agricultural seeds. On our side, we import in quantity only a few kinds, the culture of which is still comparatively new in this country. Of necessity, the improvement of machinery for harvesting, thrashing, and cleaning seed has kept pace with the increased output. This could not have been otherwise, since without better machinery the seed of some grasses, and even of clover, could not have been economically produced in quantities sufficient to supply a large demand. The domestic production of seed has tended to reduce prices, and to-day the seeds that are so expensive as to seriously limit their use are all imported. In some cases, not counting cereals and flax, the seeds of agricultural plants have assumed such importance in trade that they are quoted on the produce exchanges or on the boards of trade of all the large cities, and dealing in futures in clover and timothy seed is as regular a part of the trading as in the case of corn or wheat.

That the trade in agricultural seeds has assumed enormous proportions needs only to be mentioned. Unfortunately data are not available for making reliable calculations of the

quantities and value of all seeds produced or sold in the United States. Some statistics are, however, at hand showing the amounts of clover and timothy seed produced by a few states. The export trade in clover and grass seed during the year ending June, 1900, amounted to $3,050,193, and of course the domestic trade is vastly greater. In 1900 the clover seed crop of Illinois aggregated 52,992 bushels, and Missouri sent out of the state 51,683 bushels. In 1899 Ohio reported 350,777 bushels of clover seed produced in that state; in the same year Michigan produced 68,744 bushels, Wisconsin 85,423 bushels, and Missouri more than 30,000 bushels. In 1897, a year of large clover crops, 810,341 bushels were grown in Indiana alone.

In 1900 Illinois produced 103,401 bushels of timothy seed, valued at $188,831, and 60,649 bushels of Hungarian and millet seed, worth $37,770. The crop of timothy seed raised in the state in 1900 was the smallest for more than twenty years, the high water mark for value, although not for production, having been reached in 1881, when the timothy seed crop was worth more than $1,000,000. The amount of timothy seed harvested in Wisconsin in 1899 was 61,786 bushels; while Missouri, in the same year, produced 72,535 bushels, besides more than 1,000,000 pounds of unclassified grass seed. In 1900 Missouri reported the amount of timothy seed exported as 2,976,648 pounds, and of millet seed as 2,851,300 pounds; in the same year Iowa produced 114,700,950 pounds of timothy seed.

These figures serve to convey some notion of the volume of the trade in agricultural seeds in the United States.

While most of the important seeds can be produced throughout the greater part of the United States, yet there are centers where these seeds are produced most abundantly and most cheaply, and from these the commercial supply is therefore largely drawn. Not only does the trade look for sections in which such seeds can be most cheaply produced, but also where those of the best quality are to be had. Certain sections have the reputation in the seed trade (whether well deserved or not is in many cases still an open question) of producing the best quality of a certain kind of seed. For

example, the more critical trade always demands Tennessee or southern grown German millet seed, although the western seed is cheaper. Seedsmen believe that the southern seed gives better crops than seed produced in Nebraska or the northwest. So also northern grown red clover seed is more valued than any other, and commands the highest price in the market. These areas of production are in some cases rather limited, and in others are co-extensive with the boundaries of many states. Sometimes the areas of production are localized and separated by thousands of miles, chance or similarity in conditions having given birth to the same industry in widely distant places.

For the purposes of a general survey of the areas and methods of production, agricultural seeds may be divided into the following classes:

Cereals, including such seeds as wheat, corn, buckwheat, oats, rice, and the like.

Clover and other leguminous forage plants.

Common grasses and grass like forage plants, including among the latter the various sorghums, teosinte, etc.

Fancy grasses.

Miscellaneous agricultural seeds.

This classification is, of course, rather arbitrary, and is used solely as a matter of convenience.

The trade in cereals for seed purposes must be carefully distinguished from that trade in wheat, corn, etc., which is a daily feature of the Chicago and New York markets. Seed wheat is not bought on 'change, nor is the price of high grade seed corn affected by the fluctuations of the market. The great bulk of the seed of the cereals is undoubtedly grown in the locality where it is to be used; most of it does not move far. The seed that is offered for sale by dealers is obtained in three ways: Some dealers buy seed in the open market, selling by the name under which the seed was bought, without inquiry of any sort into the quality or the origin of the seed. Such dealers usually sell seed that should have found its way to the nearest gristmill. Other dealers, while buying by sample in the open market, use all the care the circumstances permit to obtain correctly named seed of good quality. This

seed is, if necessary, recleaned, the light and injured seeds removed, and only good, sound seed exposed for sale. A third and small class of dealers make a specialty of some varieties, and these are grown for the dealer under contracts in the same way that vegetable seeds are grown. Such seed is of the highest quality, and what is of great importance, is almost always true to name. In general, good seed of any of the different classes of wheat comes from the section in which that class is most commonly grown. For example, seed of Turkey red wheat should be bought in Kansas, Nebraska, or Iowa; Sonora wheat in California; hard spring wheats in the Dakotas, Minnesota, or states in that section.

It is a commonly accepted rule that plants raised from northern grown seed will mature earlier than those from southern grown seed of the same variety. This rule holds good for spring sown wheats, of which the northern grown seed is preferred, but the contrary is true of fall sown grain, the latter ripening earlier from southern grown than from northern grown seed.

More seedsmen make a specialty of corn than of wheat, rye, or oats, and reliable dealers are reasonably careful to have their seed grown for them true to name and free from any mixtures. This is much more difficult to accomplish in the case of corn than of wheat, since the former cross pollinates readily, the light pollen being shaken from the tassels and carried by the wind sometimes for considerable distances. Wheat being self fertile, may be grown anywhere without danger of crossing, while each variety of corn must be widely separated from any other if it is to be kept pure.

The breeding of corn for seed purposes is rapidly taking such an important place in corn culture that many of the best farmers buy seed only from the members of the corn breeders' associations in the different states. These associations have been formed for the purpose of improving the quality of corn by selection and for the protection of the buyer as well as the seller of seed corn.

Buckwheat is grown from New York to Kansas, most of the seed used being of local production. Some dealers, however, have their Japan buckwheat seed grown under contract

in order to keep up the quality of the variety. Seedsmen usually buy seed by sample and reclean, losing 5 per cent or less in the process.

Oats for seed are raised wherever the oat crop is grown, but some varieties are perhaps more grown for seed in some states than in others, Texas and Georgia, for example, being possibly the largest producers of the rust proof oats. The varieties of winter oats are all grown south of the Ohio, while the best seed of spring oats is northern grown. Unless seed is grown on contract, it is bought by the dealer on sample and not by grade.

Rice is, of course, produced in the southern states. The seed rice is grown in the same way as that which is to be used for food and harvested at the same time. The time of harvest for South Carolina is August 20 to September 20 for early rice and October for late rice. That intended for seed is not thrashed with the other, however, but is removed by whipping the straw over logs or beating with a flail. The straw is then passed through a thrasher to save what grain is left on the straw. The seed rice is run through a fan to take out the dirt and short straw. In Louisiana the crop is harvested in August and is thrashed with a common wheat separator, the charge being 10 cents for a sack of almost 4 bushels. Seed rice that is free from weed seeds, and especially from the red rice, commands a good price.

Five true clovers are more or less common on our farms, and of these we regularly import seed of two, the crimson and the alsike. It is true that a little red and a little white are occasionally bought abroad, but this is usually not due to a scarcity at home, but because the condition of the market enables the American dealer to trade in this way with a profit. Even so, the importation of red clover is rare and confined to very low grades, which are used to reduce the price and quality of higher grades at home. However, some mixed seed, consisting of red clover and timothy, together with other seeds, is regularly imported from Canada by New York dealers, who separate the seeds and market the cleaned clover and timothy. Alsike is regularly imported to a greater or less extent from Canada, and some from Europe. Thousands of pounds of

crimson clover come every year from France and Germany.

All seed can not, of course, go into one grade. Much of the seed coming to the Toledo (Ohio) market, for example, can not be made equal to Toledo prime, no matter how well it may be cleaned, because the seed has not the size and color requisite for the grade. Such seed is graded as Number 2 or as rejected, according to cleanness and appearance, and is sold on the Toledo board of trade under these designations. Poorer qualities are bought and sold only by sample. Some large cities have regularly authorized grades and an inspector, whose certificate is accepted in trading transactions. In other cities there is no fixed grade, dealers buying by sample or using the grades of the chief centers of the clover seed trade as a basis.

A clover seed inspector is regularly employed by the Toledo board of trade, and it is his duty to sample every bag of clover seed offered in that market, fix its grade, and furnish a certified sample to the owner of the seed. These samples are drawn by means of a trier, or clover seed sampler, which is thrust through the bag, allowing the seed to run out at the open end of the trier. The sample drawn from each bag is allowed to run into a compartment of a tray. When the tray is full the inspector examines the whole carefully, and then mixes all together to make up the sample for that lot of bags.

In all the great centers there are certain definite rules governing the trading in clover and grass seeds. These rules are usually prescribed by the board of trade or by the produce exchange of each city. The greatest part of the trading is, however, done by sample. When a firm has a quantity of seed to offer, it sends samples to other dealers, quoting price on this sample, which is known by some word, letter, or number for identification. If a purchase is made on these terms, the seed delivered must be equal to the sample. The wholesaler will commonly buy any clover seed offered, and much that comes directly from the farm is in very bad condition. Not long since during trading hours on the floor of the board of trade in one of the largest cities of the country, a sample of

clover seed was offered that appeared to be largely bracted plantain. It was bought by a dealer, who called attention to the fact that the clover seed in the sample was large, and that his machine could readily separate the clover from the plantain and get a high grade of clover out of the foul seed. Since the whole had been purchased at a low figure, there was a good profit in the transaction. From the wholesaler the seed goes to the retailer, chiefly the country storekeeper, who sells to the farmer, and thus the clover seed completes the cycle from the farmer who produces to the farmer who consumes, through the medium of the dealer acting as distributing agent.

Red clover seed is produced in every state from the Hudson to the one hundredth meridian and from Canada to the northern border of the gulf states. In the earlier years of the last century New England was also an extensive producer, but the area of the profitable production of clover seed gradually moved westward, until the New England farmers found that they could more cheaply buy New York, Pennsylvania, or Ohio seed than raise their own, and to-day there is practically no clover seed grown east of the Hudson. Later the same process was to a certain extent repeated for New York, Pennsylvania, Maryland, and Virginia. The clover fields became foul, bad seasons left poor crops, and the western seed was cleaner, larger, and cheaper, so the farmers left off raising seed and bought from Ohio, Michigan, and Illinois. To-day many farmers in the Atlantic coast states outside of New England produce their own clover seed, but practically none of it is on the market, certainly not outside of the neighborhood where it was grown.

The source of supply for the enormous volume of trade in red clover seed to-day is found in the states of the Ohio valley, besides Michigan, Wisconsin, Iowa, and Missouri. Other states produce some, but usually not enough for the home demand. Of these, Minnesota, eastern Kansas, and eastern Nebraska are producing more each year, and the center of clover seed production is steadily moving westward.

Red clover seed is an incidental crop, which is taken when conditions are favorable, but upon which the farmer does not depend with as much regularity as he does upon corn

or hay. It is therefore extremely difficult to collect reliable data for a prediction of the crop; nevertheless all the principal dealers take great pains to ascertain in advance what the prospects are each year. Though probably influenced at times by a speculative market, the price of clover seed is usually controlled by supply and demand.

The seed is saved from the fall cutting of the second year's clover crop. The early cut is made into hay, and if the weather is favorable a second crop of blossoms develops and ripens seed during the latter part of August or the early part of September. If, however, an unusually dry spell has injured the hay crop, the second crop is frequently also cut for hay. Up to the time of cutting, therefore, the acreage of clover seed is a very uncertain quantity, and the amount of seed that may be expected per acre is still more uncertain. The yield varies from 1 peck to 4 or 5 bushels per acre, according to circumstances, averaging about 2 bushels per acre as a normal yield.

The crop is cut by mowers or by self binders with the binding apparatus taken off, or by the old self rake, which is the best machine for the purpose. When a mower is used some device is generally employed to keep the clover from being trampled by the horses. When well dried the seed is hulled out by special hullers, which also partially clean it. The seed is then either sold directly from the huller or is recleaned in a fanning mill and sold to local dealers in the small towns throughout the clover belt. These men buy the seed in lots of a few bushels, and when they have accumulated a carload or two it is sent to the large centers and consigned either to wholesale dealers direct or to commission men, who resell to the wholesale dealers. The latter, of course, buy seed of all kinds and qualities, paying for it according to the market price of the grade at the time the seed is bought. They then reclean and bulk the seed, that is, mix up the cleaned seed thoroughly so as to make a uniform grade.

Mammoth clover seed is grown in the same states as common red. The seed must be taken from the first crop, since, if cut for hay, the second crop can not be depended upon to mature seed. The method of handling is similar to that described for common red clover. It is a more certain seed crop,

and is often recommended as a money crop for the seed and as a soil enricher.

Alsike clover is grown in the northwestern states, Wisconsin and Michigan producing most of the seed, while some is also grown in Minnesota and Ohio. Canada is a large producer of prime alsike, much of which comes to the United States.

A few men, chiefly in Wisconsin, make a specialty of growing alsike and white clover seed, which latter is almost all grown in that state, and in rather limited areas. These two species present no peculiar problems, except it be in the fact that from its low growth the white clover needs more care in harvesting than either red or alsike. The white clover grows wild throughout the northern states, though but little effort has been made to save the seed, except in a limited area in one state.

Crimson clover seed is produced in Delaware and Maryland, small amounts being raised also in Ohio and Virginia. The seed is ripe in the latter part of May or early in June, and is more difficult to handle than any of the other clovers. The fruit containing the seed readily falls from the head when ripe, and much is lost in this way, unless the seed is harvested just at the proper time. A rain on the cut clover or a spell of wet weather when the seed is nearly ripe may do great damage by causing the seed to sprout in the head. The home supply of crimson clover seed is not equal to the demand and much is annually imported.

Bur clover (Medicago maculata and M. denticulata), also called California clover and hog clover, which has proved a valuable plant in certain parts, produces seed wherever it grows, but there are at present two chief areas for the commercial supply of the seed. These are in California and Georgia. In both areas the method of harvesting and handling is substantially the same. The burs ripen from June to July and readily fall from the plants, which are by that time quite dry. The dry plants are then removed with pitchforks and the burs swept up with brooms.

The yield is from 50 to 100 bushels per acre, 10 pounds being the weight of a bushel of burs. The burs should be

gathered as soon as possible after they fall, to prevent their becoming black. If a rainy spell overtakes the burs on the ground the seeds germinate, which ruins the crop. When the burs are gathered they are freed from dirt and broken plant matter as much as possible, but the seeds are not hulled out of the burs. There are usually three or four seeds in each bur.

Sweet clover seed, also known as Bokhara clover seed, is nearly all grown in the state of Utah and in the county of that name. Some is also harvested in Alabama, Ohio, and New York. It is harvested with a self rake machine and is hulled in a common grain thrasher, the screens merely being changed. The fruit falls from the stalks very readily, hence great care is needed in harvesting. The harvest takes place about September 10 to October 10, and the yield is about 250 to 400 pounds per acre. The seed is sold by sample, and is usually recleaned by the dealers, who lose 5 to 10 per cent in the process.

Alfalfa seed is grown mostly in the far west, Utah and Kansas producing the largest amounts. Some is also grown in Colorado, California, and Nebraska, while in Ohio small amounts have been marketed for several years. The methods of growing and handling, alike for the most part in all places, differ somewhat in details in the various states in which seed is grown.

In Utah the seed is saved from either the first or second crop, the seed from the former being considered the best if the growth is not too rank. The first crop when taken for seed is harvested in August, the second crop in September. In Kansas the second or third crop is used for seed, and is harvested in August or September. The weather is so much more favorable for harvesting during August and September that the seed crop can be handled more safely at that time than earlier. It takes twice as long to cure a crop of seed as a crop of hay, hence steady weather is of the utmost importance.

The amount of seed secured per acre varies from 1½ bushels to 10 or 15 bushels, according to soil and season. In many places the seed is still thrashed with a grain separator,

while in some places clover hullers are used. The seed is usually sold by sample, though sometimes by grade. The dealers commonly reclean the seed they buy from the growers, losing 5 to 50 per cent in cleaning. As in all field seed purchases, allowance is made for this loss, either by both parties agreeing on an estimate of so many pounds of loss to the bushel or by actually cleaning the seed and weighing the screenings. Some alfalfa seed is imported from France under the name of lucerne, but this has been almost crowded out of the market by the western seed, and to-day it is not easy even in the eastern cities to get good imported seed in large quantities.

Perhaps the most important of the leguminous forage plants besides those mentioned above is the cowpea. The area in which this great nitrogen gatherer is used as a soil enricher increases every year, and the demand for seed is such that the price remains at about $2 per bushel. The cowpea is a plant of warm weather and long season, so that with some exceptions the varieties do not produce seed, or at least can not be depended upon to produce seed, north of the Ohio river. The crop is grown and seed produced in almost every southern state and upon almost every farm. In many cases it is planted as a catch crop in corn, and then the yield is 5 to 10 bushels per acre. If properly cultivated, it will yield 10 to 30 bushels.

Cowpeas are allowed to become well ripened before harvesting, which is commonly done with a mower. The vines are piled in small cocks and frequently turned until dry. Thrashing is best done with a bean thrasher, but a wheat separator may be used with the concave lowered and many teeth removed. In some places also the flail is resorted to or the peas are trampled out by horses on the barn floor. The seed is sold by sample, as there is yet no standard grade or price.

The soy bean, which shares with the cowpea the reputation of an excellent forage and fertilizing crop, has a more northern and western range than the latter. The early varieties mature seed in Ohio and in Kansas, and some varieties seed very heavily. The pods grow close to the ground,

and the ordinary harvesting machine can not be successfully used. For small areas a knife cutter is recommended, consisting of a sharpened piece of strap steel bolted to a two horse cultivator. This knife runs just below the surface of the soil and cuts the stems, which are not so hard below as they are above ground. For larger areas special harvesting machines are used. Thrashing is done with an ordinary separator, using all blank concaves, and running as slowly as the machine will permit and not clog the shaker. Care is needed in keeping the seed. It should be stored in loose woven bags, only partially filled and kept dry. If put in close bags or in deep bins in quantity the seed may heat enough to injure its vitality.

The yield in Kansas varies from 15½ to 30 bushels per acre, according to the land, and the expense of growing, harvesting, and thrashing the crop is about 55 cents per bushel.

In the extreme northern states and in Canada the place occupied by the cowpea in the south is taken by the Canada field pea. This is a genuine pea, which the cowpea is not. It is known to the trade in a number of varieties, the seed being mostly produced in Canada, Michigan, and Wisconsin. Some seed is produced in Oregon.

The seed of the hairy vetch, which has proved to be a valuable cover crop and early forage plant, is at present practically all imported, and commands such a high price that extensive planting is out of the question, but yet the supply is not equal to the demand. It comes chiefly from Germany, where the hairy vetch is much grown. When planted for seed purposes from one half to two thirds as much rye is planted with the vetch to furnish support for the latter. The rye and vetch ripen and are harvested at about the same time, and since it is difficult to separate the seeds perfectly, hairy vetch seed usually contains some rye.

It is the common opinion among dealers that the vitality of this seed, which is often poor, is seriously affected by the sea voyage, and it is thought that storing in bags is also injurious, open bins being recommended. A little of this seed has been grown in the United States, but the question of profitable production appears to be chiefly one of labor. The

pods ripen irregularly, and hand picking is necessary to secure a full crop.

The velvet bean, a rather new forage and fertilizing plant, produces seed only in the extreme south of the United States, Florida, especially the southern portion of the state, producing most of the seed, some being also grown in Louisiana. The beans need a long season to mature, and ripen late in the fall. The pods grow in clusters of 12 to 18 pods, and harvesting is usually done by hand picking. The pods are thrown into barrels, which hold about 100 pounds, and will shell out approximately 1 bushel of clean beans, the accepted weight of a bushel of beans being 60 pounds. The barrel of pods has become a standard in the sale of these beans, and pods are bought by the barrel or by the bushel of 100 pounds; in either case it is expected that there will be 60 pounds of clean beans.

The beans are usually marketed in the pod, few farmers having the machinery necessary to thrash and clean them. The buyers thrash out the beans with special machinery designed to prevent breakage. Attempts have been made to thrash from the vine with separators in order to save the labor of hand picking, but the chief trouble has always been with the breaking of the seeds. Some growers prefer to harvest by gathering up the vines. When these are green they are pulled loose by running a triangular harrow over the field, after which the vines are raked into piles to dry. If the crop is not wanted until the vines are dead they may be raked up with a horse rake. It is claimed that while in hand picking about 30 per cent of the pods are left on the vines there is practically no waste when vines and all are gathered. The vines are run through a separator built much like a wheat separator. This cracks more seed than the huller, but those who prefer this method say the broken seeds are just as good for feed, and hence there is really no waste.

Another Florida product is beggar weed (Meibomia tortuosa) seed, of which only a small amount is saved, most farmers permitting the plants to reseed themselves. This they do abundantly, so that by the time the corn is ready to harvest the beggar weed is often higher than the corn. The

seed is hand stripped, and is mostly sown in the rough. When cleaned it has the color of old alfalfa seed, is glossy, and is shaped somewhat like a small bean.

Of all grasses used for hay and pasture, timothy is doubtless grown more widely than any other. Four other grasses—meadow fescue, orchard, Kentucky blue, and redtop—produce seed abundantly in the United States, and the seed crop is of considerable value. Besides these, the seed of beardless brome grass (Bromus inermis) is now produced in the northern United States and in British Columbia, but not yet in sufficient quantities to supply the demand. Many thousands of pounds are still imported every year, although, as a rule, the quality of the imported seed is not equal to that of the domestic.

Enormous quantities of timothy seed are sold every year, many thousands of pounds being exported. The chief market for this seed is Chicago, where hundreds of carloads of seed are handled every season, and whence it is distributed to other points, more especially in the eastern states.

The seed is grown in many states, from Ohio to Idaho, but for the trade chiefly in Illinois, Missouri, and Iowa, the southeast corner of Iowa being perhaps the most important timothy growing section in the world. In Utah and Idaho fine large seed is also produced.

Timothy seed is harvested about July 15 to 20, and is thrashed with a common separator. The cleaning is mostly done by dealers, from 1 to 10 per cent being cleaned out. The seed is sold either by sample or by grade, the Chicago grades being known and used by many merchants within the area supplied by the Chicago trade. Timothy seed is usually sown in the fall, and consequently the trade in this seed is brisk from shortly after harvest time until November.

The seed of meadow fescue (Festuca elatior pratensis), also called English blue grass, is nearly all Kansas grown. The industry began in that state in Johnson county, which still leads in the production of the seed. Other counties in Kansas and portions of northern Missouri, Kentucky, and Ohio also produce some seed. Kansas is said to produce 75 per cent of the crop in the United States, the largest crop, amounting to 140,000 bushels, having been harvested in 1896.

Meadow fescue yields the best seed crops for from three to five years after planting, after which there is a decline, and the fields are plowed and planted to other crops. Good crops are from 6 to 12 bushels (of 24 pounds) per acre, though 15 to 18 bushels are often secured, and sometimes, but rarely, the yield is as high as 20 bushels. The crop is harvested directly after wheat, with the same machinery and handled in the same way, thrashing being done with a wheat separator at a charge the same as for grain, or sometimes double that amount is asked.

The seed is sought at harvest time, or soon thereafter, by wholesale seed houses in the west, either by letter or through representatives who personally visit the farmers to make purchasing contracts. The competition of the seed firms ordinarily induces the paying of prices to growers in line with conditions of supply and demand, but demand is the prerequisite factor. The annual foreign requirement is an uncertain quantity, and hence varies. Home needs are not material in influencing prices. Formerly western seedsmen resold to Atlantic board exporters, but they now sell direct to foreign importers. The seed goes to Germany, Denmark, the Netherlands, France, Holland, Great Britain, Australia, and some to Ireland, in all of which it is sown for pastures and meadows, mixed with other grasses. Germany is the largest taker.

Orchard grass seed is a Kentucky product, although some is grown in southern Indiana and in Nebraska, and small lots in southern Virginia and in Maryland. This seed is also largely grown in New Zealand, and comes in competition with the Amercian seed in the European markets. It is sometimes even placed on the American market, but as yet infrequently and in small lots. In Kentucky orchard grass seed is harvested in the latter part of June. Some allow sheep to pasture in the fields after the flower stalk has been sent up, because they will eat the weeds and clover, making the work of harvesting and thrashing easier. The grass is cut with a self binder, tied in bundles, and left to dry in uncapped shocks. The seed is thrashed with wheat separators having specially constructed sieves. As it comes from the

thrasher the seed needs recleaning to make high grade seed, but much is sold just as it comes from the thrasher; it is commonly sold by sample. The crop is from 8 to 20 bushels per acre.

The seed of the Kentucky blue grass (Poa pratensis) is, like that of orchard grass, mostly harvested in Kentucky, the blue grass region being about Lexington, Paris, and Winchester, and thus east of the counties in which orchard grass seed is produced. Some blue grass seed is also saved in Iowa and in northwest Missouri, and the amount is steadily increasing. Owing to care in curing, the western seed is often of the very best quality.

The seed of Kentucky blue grass is harvested by stripping the seed from the panicles with either a comb or a rotary stripper. The rough stripped seed contains portions of the stems of the blue grass, weeds, leaves, and other rubbish. The entire mass is put into sacks and carried to the curing ground, where it is spread out in windrows to cure. Here it must be frequently turned to prevent heating, because if this is not done the pile of seed and green stuff quickly attains a high degree of heat, and injury to the seed results. When dry, the seed is cleaned by specially constructed machinery, which removes the chaff and the wool and turns out clean and smooth seed of the grade known as fancy.

There are two grades in the trade, the fancy and the so-called extra clean, which consists of the chaff and light seed left after the fancy has been taken out. The seed is sold by sample, since all lots of fancy are not of the same quality. It is sometimes adulterated with Canada blue grass seed. The weight of export fancy is 22 to 23 pounds per bushel, sometimes even going higher; but the domestic trade takes a lighter grade, weighing 19 pounds, more or less, to the bushel.

Most of the redtop seed is produced in the southern part of Illinois, while some seedsmen report that a part of their supply comes from New Jersey. The seed is harvested during July, and in two ways—some still employ mowing machines, cutting the grass as hay and cocking or stacking after the grass is dry, while the new method is to harvest the seed by stripping with a rotary stripper like the one used for harvesting

the blue grass seed. When the new method is used, the grass is subsequently cut for hay, and the seed is thrashed in a grain thrasher, just as is done when the grass is cut by the old method. In thrashing, the wind is entirely shut off and suitable riddles are put in.

When the seed is thrashed, it contains a certain proportion of clean hulled seed, some good seed with the hull on, and some chaff. There is also a variable percentage of timothy, clover, and weed seeds. The farmers do not, as a rule, attempt to separate the fancy seed, as the clean hulled seed is called, from the balance of the crop, but sell the whole to cleaners, who separate the different grades of redtop from the other seeds and chaff. The good seed in the hull is known as prime seed.

The northwest is rapidly becoming a source of supply for the seed of beardless brome grass (Bromus inermis), although much is still imported. The seed is grown in Minnesota, the Dakotas, Oregon, Idaho, and Washington, as well as in the British territories to the north of these states. The seed is harvested when fully ripe, although care is taken to cut before the seed begins to shatter. Harvesting is done with a self binder, set so as to cut high, and thus take in as little of the leaves as possible. When well dried, the seed is thrashed in a wheat separator, using an oat sieve and shutting off most of the wind. Some claim to use special devices, but if the seed is allowed to become well ripened before harvesting it can be thoroughly cleaned in an ordinary separator. Samples of Idaho seed have been received that were more than 90 per cent pure, and others grown in North Dakota during the present season contained 97.5 per cent pure seed, 94 per cent of which germinated.

The amount of seed secured per acre varies much, some growers reporting 150 to 600 pounds, while others give 10 to 300 pounds as the range. According to the tests at the Minnesota experiment station, it costs about 10 to 12 cents per bushel to thrash the seed. As there is no established grade, the seed is sold by sample, and the price varies widely, there being no constant and well defined relation between quality and price.

The different varieties of millet are grown for seed in many states in the south and west, from Georgia through Tennessee, Indiana, and Illinois to Wisconsin and Minnesota on the north, and as far as Kansas, Nebraska, and Texas to the west and southwest. A little is also produced in Oregon, but almost wholly on special contracts with dealers. This is also the case in Pennsylvania and Massachusetts, where some dealers grow their seed of Japanese millet on contract.

Although the general range is so wide, all varieties are not grown throughout this entire range. Pearl millet is largely a Georgia product. The headquarters for German millet is in Tennessee, but Texas produces some, and it is also grown in other states, notably Indiana, Illinois, Nebraska, and Kansas, where also the common millet is grown. Some seed of the latter variety comes from Wisconsin, Minnesota, and Michigan.

The German millet seed grown in Tennessee and in Texas is more highly valued in the trade than that of the same variety from the north and west. It is generally believed by seedsmen that the more rounded seed from Tennessee will produce a better crop than the somewhat elongated western product. At any rate, higher prices are willingly paid for southern seed, and dealers not sufficiently familiar with its appearance are sometimes imposed upon by having western seed delivered to them at the price of southern. It is impossible at present to decide how well founded is the trade belief in the superiority of southern grown seed, and the fact is recorded here simply because it has an important bearing on the price.

The harvesting and cleaning of millet seed do not differ much from the same operations in the case of wheat. The crop is cut with a self binder as soon as ripe, to prevent loss of seed by shattering. When dry, the seed is separated by a grain thrasher. It is sold both by grade and by sample.

Under the title of Sorghum we include all the varieties of Sorghum vulgare, such as Kafir corn, Milo maize, Jerusalem corn, Dhoura, Early Amber cane, Orange cane, and what is more generally known as sorghum. These varieties are grown more or less throughout the central United States from Ohio

to Kansas and from Georgia to Texas, special strains of early varieties being raised in the more northern states. The principal seed producing states are Kansas, Nebraska, and Iowa.

The method of harvesting and cleaning is essentially the same for all varieties, and is described for Kafir corn.

When fodder as well as seed is wanted, the stalks are cut, preferably with a corn binder, but when only the seed is desired, a header is used, which takes off the heads and a small portion of the stalks. Thrashing is done with a grain separator. If the entire stalk has been cut with a binder, the bundles are thrust for a moment into the cylinder, which removes the grain, and the stalks are taken out and thrown aside. A common method is to cut the heads from the stalks before thrashing, using a broadax or a knife on a block connected with a wagon box, or arranged in any other convenient way. The heads are then run through a separator the same as those that have been headed in the field. Care is taken that the seed does not heat, which it is very likely to do when stored in sacks, and by which the vitality is quickly injured. The crop varies from 20 to 75 bushels per acre, even more being sometimes reported. The seed is sold by sample, and is usually recleaned by dealers, who claim to suffer a 5 per cent loss in cleaning, some even reporting 15 per cent in certain cases.

Johnson grass is another species of sorghum (Sorghum halepense), and is known by various names, as Evergreen millet, Mean's grass, Guinea grass, Green Valley grass, and Cuba grass. The seed is largely a Texas product, but is also saved in Louisiana, Mississippi, and Alabama. It is harvested early in July with a self binder, shocked, and thrashed with a grain thrasher. The seed is not usually recleaned by growers, being considered clean enough directly from the thrasher, though jobbers often reclean seed and claim that they lose 5 per cent in cleaning. An average crop is from 8 to 10 bushels per acre, and two crops of hay are subsequently taken from the land. If the conditions are favorable, a second crop of seed may be secured, which ripens September 1 or later, but this crop is uncertain, and is not depended upon. The straw left after thrashing the seed has some feeding value, and sells

for 75 per cent of the price of regular hay. The seed is sold by sample.

The teosinte seed raised in the United States is exclusively Florida grown, the extreme southern part of the state supplying nearly all the seed sold in this country. Foreign seedsmen have their seed grown in Egypt, and some is said to be grown on the plains of Algiers. In Florida the plants are grown in rows, and are sometimes cut once or twice before being allowed to produce seed. The seed ripens in December, and is thrashed with a regular grain thrasher. It is sold by sample, and is recleaned by dealers, who claim to lose about 5 per cent in the process.

The grasses filling less important places in the economy of the American farm are mostly imported. Canada blue grass is raised along the northern shore of Lake Erie and some in New York state. The Canadian seed is almost all sold in the United States, the greater portion being used to adulterate the seed of Kentucky blue grass.

English and Italian rye grass seed are imported from Ireland and Scotland, some being also raised in Germany and France.

The seed of rescue grass (Bromus unioloides) is produced in Texas, in Louisiana, and perhaps in Georgia, although Georgia rescue has lately been confounded with cheat (Bromus secalinus), which has been sold as Arctic, or rescue, grass. In Texas the yield is about 40 to 50 bushels per acre. The grass is cut with a mower, raked into windrows, and cleaned with a flail. The seed is sold by sample. Texas blue grass seed (Poa arachnifera) also comes from the same county (Ellis) that produces the rescue grass seed. The former is all gathered and rubbed by hand, hence the high price of the seed. This grass is more frequently propagated by sets, which are grown in Georgia and Louisiana. Tall meadow oat grass seed is grown in Virginia and Oregon.

The seed of the so-called fancy grasses and of Bermuda grass is imported, the latter from Australia, the others from different European countries. The seeds are mostly gathered by hand and in small quantities in meadows, woods, and fields. Some of these seeds are raised to a certain extent in

the United States, but the demand for them is not enough to warrant their production in commercial quantities.

In this class we include a few important staples, as cotton, tobacco, rape, flax, hemp, and sugar beet, and some minor crops, as broom corn, wild rice, saltbush, and pumpkin.

Cotton seed is produced in all the southern states, and is usually sold, without grade or sample, being used for seed just as it leaves the gin freed from the lint. Commonly, no selection is practiced, and seed is planted frequently without even the name of the variety being known. More careful growers, however, plant a few acres each year for seed purposes. This patch receives the best of care; the cotton from the plants so grown is ginned separately and the seed is used the following year. Besides this, a sufficient number of plants to plant the seed patch again are specially selected, and the seed they produce is planted to grow the seed crop of the next year. A great deal of special breeding is now going on among cotton experts, but such careful methods have not yet come into general use.

Tobacco seed is grown commercially in Virginia, but the best tobacco growers save their own seed. The tobacco produced in all the important tobacco sections has a character of its own, to preserve which the growers must use seed saved from selected plants grown in the locality where the tobacco is to be raised. Maryland farmers would not think of using any but their own seed to produce the particular kind of tobacco they grow. In Pennsylvania, the Havana tobacco has taken on a character of its own, and imported seed can not be used the first year for producing a crop. Not till the third generation can the seed be depended upon to yield a crop equal to the regular Pennsylvania Havana, and each year thereafter the grower saves his own seed from selected plants.

The Florida grown Sumatra tobacco is preferably raised from seed taken from the first or second generation after importing the seed. Careful men save enough of the seed of these crops to last for ten years, hanging it up in bags, and using it year after year. The seed retains its vitality and produces better tobacco than seed saved from a later generation.

Hemp seed is raised in Kentucky, Missouri, and eastern Kansas, most of it being, however, sold as bird seed. When hemp is to be grown for seed it is planted in hills 42 to 48 inches apart, and is cultivated like corn. It is sometimes topped to make it spread and produce more seed. After the male plants have shed their pollen they are cut out. The seed is thrashed with a flail in a wagon box or any other convenient place, or beaten out over sheets of cloth spread on the ground. Much seed is also produced by plants grown for the fiber. This is known as lint seed, and is light and inferior in quality. It is not used for seed purposes except in years of short crops, when the heaviest of the lint seed is cleaned out to be sold for seed. Growers commonly prefer a small dark colored seed.

Small quantities of seed are annually imported from China, France, and Italy. The seed from China is mostly received through missionaries in small packets, and is highly prized. The first year it is sown for seed purposes exclusively, and does not at first yield as good fiber as the American plant. The Chinese variety rapidly becomes acclimated, and the seeds of the second and third generations produce plants with fiber of the best quality. The occasional importation of the Chinese seed is necessary to keep up the quality of the American hemp, which tends to deteriorate.

Flax seed is produced in several northwestern states, but it is mostly used for crushing. The usual practice of farmers is to save out enough seed for the following spring's sowing. Such seed is often selected by the fanning mill, or the common run of the market seed may be used. The seed grown in the north and sold on the Chicago market for crushing produces a plant with inferior fiber, but some farmers use their own seed rather than pay the extra price for imported seed. Seed from flax grown for fiber in Michigan is thrashed and used for seeding, but little selection is practiced, and the plants degenerate. To save this seed the flax plants are pulled, tied in bundles about 4 inches in diameter, and stood in shocks like wheat until dry. The seed is then thrashed by passing the seed ends between smooth rollers, which crush the capsules and partly break them off. Other machinery is used to complete the

thrashing, and the seed is cleaned with a fanning mill. The best fiber is produced from plants grown one or two generations in this country from seed imported from Riga, Russia.

The use of rape for sheep and hog pasture is constantly increasing, and the seed used east of the Rocky mountains is all imported, mostly from England. In Oregon, rape seed is being grown, and although there is not yet enough to supply the home demand the prospects are favorable for an increase of the output. The first seed crop placed on the market was grown in 1900, but some farmers had been growing their seed for several years. The rape to be saved for seed is pastured with sheep until March, when the flower stalks begin to come. The crop is harvested with a mower or harvester, but is not bound, and the seed is thrashed out by a common thrasher. The Oregon agricultural college has grown rape seed, harvesting (during 1901) 2,331 pounds from 2.17 acres. The seed ripens from the latter part of May to the middle of June. Louisiana farmers also grow some rape seed, but only for their own use.

Field pumpkins are grown in many states, and most farmers save some seed for their own use. The seed grown for the trade is, however, supplied by regular growers, who raise the pumpkins on their own farms or by contract with neighboring farmers. The average yield is 3 bushels per acre, a bushel being 28 pounds. The seed is harvested in October and November, and is removed from the pumpkins by hand. It is sold by sample, the price ranging from 2½ to 5 cents per pound.

The seed of the Australian saltbush comes partly from Australia, and the remainder is grown in the western states, chiefly in California, In the latter state the seed is harvested by hand in August and cleaned by the growers. It is sold by sample.

Wild rice (Zizania aquatica) is gathered in the swamps about the lakes in northern Minnesota and Wisconsin. The Indians go out in canoes early in September and beat the seed off into the boats. It is later recleaned and sold by sample.

Broom corn seed is largely grown in Iowa. It is harvested in September and the seed removed by a special machine called

a stripper. The crop runs from 1,500 to 2,500 pounds per acre and is recleaned, the loss being from 20 to 25 per cent. As soon as the seed is dry it is placed on the market and sold by sample.

Alfilaria (Erodium cicutarium), which is coming into use as a forage plant in the Pacific coast states, produces seed wherever it is grown, but the seeds are difficult to collect free from weeds. They are always gathered by hand from the ground in May or June, according to the season. The seed is sold by sample, and whether or not it needs recleaning depends upon the time it is gathered.

Sugar beet seed is practically all imported. Some is produced in Utah and some in California, and a few of the experiment stations and some of the sugar beet manufacturers have made more or less successful attempts to grow good seed. In Washington state beet seed has been raised from beets taken without chemical selection from fields that yielded an average factory return of 20 per cent, some beets going as high as 24 per cent. This seed in turn yielded beets for which the factory returns showed 19.9 per cent sugar and 88 per cent purity, while beets in the same field from best imported seed contained 18.59 per cent sugar, with a purity of 85.67. So far, however, these results have only just passed the experimental stage, and the amount of seed produced in the United States is not large enough to materially affect the importation of German and French seed.

Sugar beet seed growing requires more skill and care than does the growing of any other agricultural seed, and there are few even of the finer flower and vegetable seeds that require so much attention and labor to produce. High grade seed is grown only from mother beets, every one of which is examined for shape, character of leaf, and keeping quality, and tested for sugar content. On large farms, where thousands of pounds of seed are grown each year, there are well equipped chemical laboratories in which every beet is tested before it is planted. This is done by taking a core out of the beet and subjecting it to an analysis for sugar content. Only those beets that contain a sufficiently high percentage of sugar are used as mother beets. The seed from the mother beets is planted the next

year and the resulting plants allowed to grow thickly in the row. A large number of undersized beets are grown per acre in this way. These are dug, stored, and planted out the following spring to produce seed for the trade. This is the common practice abroad, but it is claimed that better beets could be grown if the seed from the tested beets were used to produce the beets for the factory. By the common practice, the tested beets really become grandmothers, the mother beets being small, inferior roots, designed wholly for seed production.

Sugar beet seed is sold on guaranty and is carefully tested for moisture content, purity, and germination. If the seed does not reach a certain standard in regard to these points, it may be rejected or the seller may submit to a pro rata reduction in the price. These tests are made at stations established for the purpose of testing seeds, and according to rules and regulations adopted by various societies or stations. There are a number of standards for the quality of beet seed and several ways of determining the real value of a sample. The best known and most important are the Magdeburg and the Vienna standards. The former have been adopted by the German Beet Sugar association and are recognized throughout Germany. Probably all of the seed sent to the United States is sold under the Magdeburg rules. The Vienna standards are in force in Austria. The germination tests to determine the value of the seed are made under such conditions that the temperature and moisture may be controlled, the former being kept for eighteen hours at 20° C. and for six hours at 30° C. Since the most important matter, the quality of the beets that will be produced, can not be determined by an examination of the seed, careful buyers deal only with growers of established reputation on whose word they may depend for the most important information regarding the quality of the seed.

LARGEST FARM IN THE WORLD.

BY JOHN H. RAFTERY.

[John Henry Raftery, journalist; born St. Joseph, Mo., June 24, 1866; graduated from the college of the Christian Brothers, St. Louis, 1884; after a varied journalistic career became staff correspondent for the Chicago Record and later for the Chicago Tribune, for which newspapers he made important economic investigations; connected with the department of publicity of the St. Louis exposition; since 1904 has been editor of the Helena (Mont.) Independent.]

On the northern boundaries of Oklahoma, where the summers are long and the winters brief and mild, lies the largest farm in the world. It is the richest and most beautiful part of the land heritage of the Otoe and Ponca Indians, who lease it to George W. Miller, an American farmer, who is credited with conducting the most perfect as well as the greatest agricultural establishment on earth.

The old name of the Miller farm was ranch 101, and so it is yet fondly remembered by the pioneers of the southwest who knew the rich tract when it was only a vast cattle range. Now it is a model farm. Five hundred miles of barbed wire was used to inclose it. Not an acre of it is left idle. Even the native pastures have been supplanted by fodder crops. Nothing is left to chance. The stock is not permitted to rustle for its winter forage, nor to famish for water during the occasional droughts. The Miller farm, old ranch 101, contains over 50,000 acres within its boundary fences. It is a striking object lesson in intensive, modern farming; enormous as is its acreage, it is run with the nice accuracy of an up to date factory. It is as much in contrast with the old, slipshod, scattering methods of ranch farming as the modern harvesting machine is in contrast with the old scythe and flail of past centuries. There are now plenty of model farms scattered over the western states and territories, but there is none so large, none involving so great an annual outlay of money and work as this.

It is not many years since a secretary of agriculture of the United States described Oklahoma as a semi-arid region.

It is now admitted to be the finest wheat and corn growing land in this country, and every year adds to its productivity in bushels and money. The advance of husbandry into this new country was marked by a change in atmospheric conditions, as well as a change in the standard methods of farming. The upturning of the virgin land, the planting of orchards and shade trees, the raising of first crops, all helped to increase the percentage of moisture in the air, and brought about a perceptible change for the better in the annual fall of rain. The Miller farm is the final refutation of an old theory that the southwest would never be self sustaining until its land was cut up into small tracts, which must be irrigated and cultivated with intense assiduity. It is the finest example of the practical effectiveness of the rotation system of sowing and harvesting. So prolific is its soil that of some field crops it raises three in a year. No irrigation has been attempted, and none is necessary. It has demonstrated beyond question that, no matter how large the herd of cattle, it pays to raise winter fodder and to feed the animals during the frozen months. It costs nearly $100,000 a year to keep this vast farm in operation. Of that total nearly $25,000 is paid to the Indians of the Ponca and Otoe tribes as rental and for their aid in gathering the harvests. In the course of a year 300 men are employed in plowing, sowing, cultivating, and harvesting the 500,000 bushels of grain which is annually shipped to market. Of these not more than twenty five are cowboys, broncho busters, and line riders. The day of the hard riding, quick shooting, picturesque horseman of the prairies is gone, and in the haying season the peaceful cowboys of the Miller farm may be found riding a sulky rake or oiling a traction engine.

Even when he rides forth in the winter, galloping his broncho across the white reaches of the farm, his Winchester and his revolver are not dangling at saddle bow and belt. Instead he carries a hammer at his pommel and a pair of wire nippers in his belt, for he is riding the line, an occupation which involves nothing more hazardous or adventurous than the mending of the barbed wire fences. Instead of the whisky bottle of the old days he carries an oilcan to lubricate the

windmills which pump drinking water for the cattle. He even wears a derby hat, and the woolly chaps of the vanished range are replaced with well fitting corduroys and military leggins.

The two dozen farmers, the six machinists, the blacksmiths, even the dairymen of the big Miller farm outrank and outnumber the little company of cowboys and broncho busters. Peace, discipline, and perfect order prevail. There is nothing haphazard about the conduct of the establishment. An office as large and as well appointed as that of a country bank is the executive headquarters of the Miller farm. Joseph Miller, one of the sons, is treasurer and financial manager. There are bookkeepers, stenographers, and clerks. The big farm is held to a strict and economical accounting, just as a factory might be. Indeed, it is a kind of automatic wheat, corn, oats, barley, hay, cattle, and pork factory. Every acre produces at least one crop a year. The alfalfa fields yield three. Ten thousand acres are sown to wheat each season. About 3,000 are given over to corn; sorghum flourishes on 2,000 acres, and oats, barley, millet, kaffir corn, and cowpeas are alternated on 1,000 acres more.

During the harvest days 200 extra men are required to handle the product of the fields. In winter fifty men are enough to look after the 8,000 head of cattle in the corrals, to repair the implements, to fix the fences, and to build new improvements. In thrashers, binders, steam and riding plows, wagons, harness, tools, implements, and equipments the Miller farm has invested about $50,000, and every year it is necessary to buy new machines, new harness, wagons, and saddles. With so large a force of workers and every modern invention to aid in the work this giant farm of Oklahoma is able to cope even with the unforeseen vagaries of the weather.

It is in February that the great activity of the establishment begins to make itself apparent. The horsemen of the little army of employees then sally forth into the corrals to break and train the mules and horses that are to do their part of the work during the coming seasons. It is one of the practices of the institution to sell no unbroken horses or mules, but in the business of breaking and training draft or harness

animals, the necessary teaming and driving of the farm is made part of the schooling of the young beasts of burden. This is economy of a quality never dreamed of by the farmer or ranchman of the earlier period, who was content to sell for a low price the horses which he had fed but had not worked, animals that he had reared without ever getting a day's work out of them.

The cornfields are ready to be sown by March 1. Twenty men are assigned to each field, and the planting is completed within a few days. A squad of twenty men is then assigned to the sole work of cultivating corn, and they do nothing else but tend their own teams and cultivators, watch, and nurture the 4,000 acres of cornfields till June 15, when the corn is given its last plowing. Then cowpeas, which have come to be known as the finest fat makers for cattle, are planted between the corn rows, so that in the autumn, when the corn is ripened and harvested, the cowpeas have attained their growth and form a superior pasturage for the live stock of the farm. Thus double service is exacted of the land, and, instead of impoverishing the soil, it has been found that the alternation of the crops and the invasion of the cattle result in reinvigorating the earth and enhancing its productivity. Meanwhile the wheat has been ripening, and about June 25 all hands are occupied in the work of harvesting and thrashing it. The twenty days set aside for the completion of the task of finishing 10,000 acres of wheat will seem all too few to the farmer who still clings to the old fashioned methods, but the forty two binders of the Miller farm, working simultaneously, will cut and handle 600 acres in a working day. The four steam thrashers, which are used in the harvest fields of the great farm, running day and night, will often complete the whole work by the time the last shock of wheat is cut, hauled, and delivered into their ravenous maws.

From the first day of March till the snow flies there are no idle days on ranch 101. No sooner is the fallow cornfield ready than the sowers attack it. When they have done their work they find other duties ready for them in other fields. When the corn is up the cultivators give it all their days, and when the June sun has brought it to mature growth

the corn tenders go into the wheat fields, where the wheat is ready for the clattering blades of the reapers. The corn cutters follow the plowmen, who ride through the furrows in June for the last time, and when the tall stalks are gathered, shocked, and separated, the workers join the wheat harvesters for the final work of thrashing, sacking, and housing the grain.

Even the frosty days of early winter, although the work slackens, are busy ones about the central shops and buildings of the farm. The machines are hauled from the fields, the harness is ranged upon the racks in the saddlery, the forge fires are kept burning all day long, and the business of getting ready for the work of the new year is begun when the results of the old one have been scarcely counted. None of the wasteful neglect of old style farming is permitted. The machines and implements are all mended, oiled, and stored in dry quarters; harness and saddles, wagons and tools are put in order and safety. Then winter feed cutting is in order; scientific rules govern the mixing and apportioning of the fodder; new shelters are provided for the calves, and plans are completed for the housing, watering, and sorting of the grown stock. The fifty scattered windmills which supply the pasture lots with water for cattle must now be examined, strengthened, and repaired against the harsh winds of winter. Repair wagons are sent out equipped with tools and manned by trained mechanics. The repair gang spends a week on the tanks, troughs, pumps, and windmills. The line riders are sent out to mend or renew the broken or wavering fences. There are more than 100 miles of barbed wire fencing around the limits of the big farm. If there is much work to be done the fence repairing may occupy ten days. The riders sleep at the nearest house when darkness finds them far from headquarters, and resume their work at daylight. Gates, pens, posts, staples, hundreds of miles of cross fences, corrals, chutes, and driveways have to be examined, tested, and put to rights. It is cold work, tugging at barbed wire and handling steel tools when the thermometer is about zero and the prairie wind is stinging from the north, but it pays, and it is one of the details of farming which is never overlooked on ranch 101.

The shipping of grain, cattle, sheep, hogs, and other products of this monster farm is conducted in the most deliberate and methodical manner. Extraordinary provisions for the storage of crops and for the care of live stock have been made, so that the proprietor of ranch 101 is able to send his products to market at the most advantageous time. The nearness of the railroad and the proximity of such markets as Kansas City and Chicago add to his profits by reducing the chance of shrinkage to a minimum, enabling him to calculate the results of his year's business to a mathematical nicety.

There are many other farms conducted on equally perfect lines, but there is none other in a compact tract of so great an acreage. The famous Sherman farm of Kansas is the nearest approach in size and completeness to it. For many years the Dalrymple farm in North Dakota, near Crookston, was the largest single tract of cultivated farm land in the world. Originally it comprised 75,000 acres, but it has been largely subdivided, and, while it is rated as among the richest and most valuable wheat land in the world, yet it cannot be regarded as a complete single farm, such as ranch 101, in Oklahoma. The famous corn farm of Tarkio, Mo., known as the Rankin farm, contains 16,000 acres, all planted to the yellow staple. It, too, is a foremost example of the most scientific methods of husbandry.

The wonderful success of these farming establishments has, in a measure, reversed the judgment of those who predicted that the time had passed for the big land owning farmer, and that the day was at hand when farming must be done on a small, accurate, and intensive scale to be profitable at all. The Miller farm, or ranch 101, complies with the forecasts of the scientific agriculturists in many ways. It is farmed intensively and with accuracy, but in its great extent and its marvelous profitableness it has upset the calculations of those who believed that wholesale farming had passed forever. There is no question that modern machinery is chiefly responsible for the continued and growing success of the few farms of more than 5,000 acres now operating in this country. A visit to any of the big farms mentioned in this article will astound the observer who remembers the methods of harvest-

ing or plowing which obtained even ten years ago. Machines drawn by twenty horse teams through a twenty five acre wheat field will cut, thrash, reclean, and sack the whole yield of the tract in a single day. This surprising contrivance completes its work as it goes along, leaving the grain sacked in the field ready to be hauled to market.

A sixty horsepower traction engine is used on some of the larger farms. It is capable of plowing, sowing, and harrowing in one operation, and will thus complete the preparation of a sixty acre field in one day. Dragging sixteen plows after it, it will do as much work in a day as sixteen plowmen working sixty four horses could do in the same space of time. Steam driven machines for almost every branch of farm work have been invented and adopted by the modern farmer. Besides the saving of wages and the absence of wasteful handling, besides the superiority of the actual work done and the accuracy with which it can be forecasted, these stationary and traction farming machines enable the farmer to make and store his harvest in one fifth the time required by the old methods. What is thus saved by escaping damages and losses on account of storms, bad weather, and delays in marketing cannot be accurately estimated, but it is one of the chief causes of the phenomenal financial success of such big farms as are described or mentioned above. While ranch 101 is now looked upon as the model bonanza farm of all the world yet it is but the culmination, the successful exemplar of many more or less successful predecessors. It is chiefly interesting to the agriculturist on account of the fact that, on account of the large capital invested and the vast scale upon which its operations have been conducted, it has demonstrated and perfected many advanced theories of the absolute science of farming.

The Miller farm has spared neither effort nor expense to arrive at an accurate knowledge of the ultimate possibilities of the new region in which it is located. It has encouraged and supplemented all the experimental work of the government and of the state and territorial agricultural colleges throughout the southwest. It planted large tracts to such crops as sorghum, kaffir corn, alfalfa and Johnson grass at a

time when the old timers flouted the theory that these drought resisting plants would not only thrive during dry seasons, but that they would, in time, become efficacious in retaining moisture in the soil and delivering it for suspension in the atmosphere.

The great width of ranch 101 in Oklahoma afforded a special and unforeseen chance to observe the gradual but evident atmospheric changes which the induction of strange vegetation brought about. The western reaches of the vast farm did trench upon a truly semi-arid region, but with the spread of vegetation, with the extension of dry sod crops, the high, dry plains of the further edges of the farm became richly productive of fodder crops that were until then practically unknown in that section.

The Dalrymple farm in North Dakota achieved a similar service in that section by proving for the first time that corn could be successfully grown in so northern a latitude. Even the small farmers of the vinicity have been benefited by the experiments and the performances of their big neighbors, since they have profited by the object lessons afforded by the experiences of such farms as ranch 101, the Dalrymple farm, the Rankin farm in Missouri, and the Sherman estate in Kansas. It is not probable that there will be an increase in the number of gigantic farms in the United States. The big Miller farm is made possible by the fact that the Indians still control the freehold and are unwilling or unable to operate their estates as profitably as the white men. As for the chance of any company of capitalists acquiring great arable acreages in the future, it is a remote, an unlikely possibility. For the small landowner of Oklahoma, of Kansas, of Nebraska, and the Dakotas has, in a smaller way, been as progressive as his richer rivals. He holds his land at a high price, and he does not want to sell at any price. He has discovered that farming need not be drudgery. He has railroads, telephones, telegraph lines, daily newspapers and rural mail delivery.

INTENSIVE FARMING.

BY B. T. GALLOWAY

[Beverly Thomas Galloway, chief bureau of plant industry of the United States department of agriculture since 1888; born Millersburg, Mo., October 16, 1863; graduated from University of Missouri, 1884; assistant in horticultural department, Missouri university, 1884–6; assistant division vegetable physiology and pathology, United States department of agriculture, 1887–8; chief of that division since 1888 and of the bureau since 1900. Author of many works on botany.]

With the rapid growth of population and the shifting of industrial centers there have been constant changes in agricultural practices. A study of the world's history shows that while agriculture has been, and will continue to be, the primary basis of wealth, it has reached its highest development where most closely allied with the factory. No country can continue to be prosperous where agriculture is the sole dependence, nor can any country hope to be independent and enjoy the best fruits of its industry where manufacturing constitutes the chief source of wealth. The farm and the factory must go side by side in order to bring about the greatest progressive, intellectual, and industrial development.

Within the last decade there has been an enormous increase in our manufacturing interests, so that it is not surprising to find that the output from the factory now constitutes 65 per cent of our annual production of wealth. Coincident with the development of factories in a community there has been a corresponding increase in the value of farms and farm lands, as well as of the products of the farm. The great era of manufacturing upon which this country is now entering is bound to have a beneficial effect upon agriculture, for aside from the great possibilities of agricultural development alone, without reference to other industries, it is clear that as factories continue to increase in number and enlarge their output, agriculture must necessarily grow to meet these conditions.

Nearly all the best arable land of the country has been taken up, and those who are most vitally concerned with soil production realize that henceforward the main problem for

the man who intends to make cultivation of the soil his occupation will be not so much a question of greater acreage as of greater production from a given acre. If America hopes to continue her phenomenal development, she must be able to produce not only the enormous quantities of food required for her own increasing industrial population, but a large share of the food for other nations as well. The average production of wheat in this country is little more than twelve bushels per acre; for corn, the average production is 25½ bushels per acre; for oats and barley, the average production is 28 and 26 bushels per acre, respectively. During the past thirty years there has been a constant variation of these averages for different parts of the country. In the great grain producing areas of the west the average has been decreasing. In certain sections of the east, on the other hand, the average has been growing higher. The important work carried on by the department of agriculture, as well as by the state experiment stations, is doing much to bring about larger yields from a given acreage. A study of agricultural statistics, especially for the past twenty years, will show that where states and state authorities have been active in agricultural propaganda work, and where the experiment stations and colleges have paid marked attention to the farms and farmers' interests, there has been a material benefit, manifested directly by new methods of crop production, new industries and diversification, and marked improvement in the value of the crop for a given area.

Recognizing, therefore, the necessity for greater diversification and greater production per acre, the question arises, in what manner can this result best be brought about? With the increasing growth of our cities and the accumulation of great numbers of people in comparatively small areas, with the extension of railroads, telephone, and telegraph systems, rural free delivery, and trolley lines, there will be an increasing demand for many agricultural products which must of necessity be grown by intensive methods, that is, such products will be of a more or less perishable nature, and for this reason they will have to be grown comparatively close to where they are to be consumed.

This necessarily gives rise to another proposition, namely, that to grow crops close to the point of consumption requires their production on land in the immediate vicinity of cities and towns, the value of which is greatly above that of the average farm lands. The more valuable the land the greater the need for economizing every foot of it and the greater the need for thorough knowledge of all the factors governing plant growth.

The population of twenty of our largest eastern cities and their contributory territory will aggregate 15,000,000 people. Both population and wealth are constantly increasing, and in consequence there is a growing demand for something more than the mere necessities of life. Fruits, flowers, and vegetables are needed to meet the requirements of life, and these, to be furnished at their best, must be grown for the most part close at hand and produced in such a way that the largest return can be secured from a given area of land with a minimum risk. To accomplish this result it must be practicable to control to a large extent climate, soil, moisture, temperature, and, in a measure, light. The only way this can be done successfully and practically is through the medium of glass houses.

A few years ago structures of this kind were looked upon more or less generally as a means for supplying the tables of a comparatively few wealthy private individuals or to serve for the growing of ornamental plants which had no strictly economic value. At the present time this view of the subject is rapidly changing and the time has come when the construction of glass houses and the production of plants under glass are regarded much in the same light as the development of manufacturing interests in a large factory; in other words, a modern greenhouse establishment is so handled at the present time that in many respects it is a factory, utilizing nature's forces in a way to reverse the seasons for the purpose of converting into wealth the products of the soil.

There is a great deal being said and written at this time about farming as a vocation. Many inducements are being held out to city people and others, and many erroneous statements are made as to the opportunities in this field. Un-

questionably there is need for pointing out the advantages of rural life, but, like all good things, the tendency sometimes is to carry the argument too far, and this results in inducing many people to go into the country or to undertake farm life who are wholly unfitted for the work. The city man is often misled by statements written by those who are not thoroughly conversant with the facts, and, again, by those who have interests at stake and who would directly benefit by inducing the prospective farmer to invest in land. It would seem well for caution on this one point and also to state plainly the facts in reference to some of the more important requirements in the matter of undertaking this line of work.

In such intensive work as must necessarily be carried on in connection with the growing of plants under glass it is essential that the man who is proposing to undertake it should be in the prime of life. It is not work for men beyond middle age, nor is it work for men with weak constitutions. While the work is not necessarily heavy, it is of such a nature as to require strict attention, and while it is for the most part in the open air and therefore not as apt to bring on certain diseases as in the case of other more confining occupations, it frequently happens that exposure is required, and such exposure can only be borne by men of comparatively strong constitutions. In addition, those who are contemplating work of this nature must or should have a thorough business training. More failures result from lack of good business capacity in this field than from all other reasons combined. It frequently happens that a man may be successful in growing crops and in getting them in good condition for marketing, but through lack of knowledge or lack of ability to appreciate the main facts with reference to the commercial handling of his products, he fails.

As a further necessity in this work, it should be pointed out that some experience is required—the more experience, of course, the better. It is not always practicable for a man contemplating entering a field of this nature to have had experience in intensive lines of horticultural work. If he cannot get it by direct practice, he should spare no effort to find out all he can as to what others are doing; visit those

who are engaged in the business; secure the various works that have been published on the subject; consult the experiment station reports; and familiarize himself in every way with what the world is doing in this field. If he will do this, and if he is a man of keen perception and observation, he will soon be able in a measure to manage his own affairs.

So much for the man. The fields that are open may be considered under several heads: general plant growing; special fields, as vegetable growing and flower growing; and then the ultraspecial fields, as specialization with certain crops, such as roses, carnations, or violets.

The field of general plant growing probably offers more opportunities than any of the others; that is, opportunities for a greater number of people. In the vicinity of every town or city having a population of from 3,000 to 10,000 there may be found in most cases good openings for the ambitious and progressiye young man who desires to supply a home market with general crops which may be grown under glass and partly in a very intensive way out of doors. The demand in towns and cities of this size, of course, is not for any great amount of any one thing; hence, the necessity for producing a variety, as ornamental plants for use in home yards, plants for cut flowers, vegetables, etc.—a general miscellaneous stock. It is essential that the location selected be within easy reach of the business limits of the city, for the grower will have to depend largely for his trade on those who may visit his establishment. Such being the case, land must be secured, if practicable, within easy access of those who may wish to visit the place as prospective buyers.

For an ordinary establishment of this nature half an acre of ground is sufficient for a small start. An acre would be better. Due attention must be given to the location with respect to soil, water facilities, and opportunities for securing fuel and other essential things required in general work. In most cases half an acre of ground under such circumstances can be bought for $500. To equip properly a small greenhouse would require another $500. For miscellaneous equipment, including tools, outbuildings, and stock, $200 would

be necessary for a start. Thus there would be invested in the neighborhood of $1,200. If the man himself wished to live at the place, as he should do, it would probably require from $800 to $1,000 for a home. In producing a variety of crops, as indicated above, the gross income from such a place should be at least $1,200 per annum. Practically, all the work on such a place could be done by the owner, with some little assistance from time to time in spring and fall. The crops handled should be a general assortment of bedding plants, a small collection of ornamentals—such as palms, ferns, etc., which could be sold as pot plants—and carnations, roses, chrysanthemums, etc., for cut flowers during the winter. A considerable portion of this work can be done out of doors, the plan being to have the outdoor crops grown in such a way as to harmonize with the plans for inside work. Of course, a definite system must be followed, and this system will in a measure depend on local conditions. A few hotbeds and cold frames will add materially to the possibilities of such an establishment and will allow the owner to increase his stock considerably, especially of spring bedding plants, which may be started earlier in the greenhouse and then moved to the frames outside as the season advances.

Vegetable growing as a specialty is more profitable near the larger cities. Cities ranging in size from 25,000 in population upward are the ones which should be considered in this connection. The reasons for this have already been briefly alluded to, but may again be referred to here. They are, chiefly, that vegetable growing must necessarily be specialized and that there can be a demand for special crops in large communities only. Since the rapid extension of vegetable growing in the south and the better facilities afforded for the shipment of such crops as lettuce, cucumbers, etc., the field for the growth of vegetables under glass has been considerably restricted. There are still good opportunities here, however, and the larger the city the more chances there are for success. The grower in this case can sell his own crops, or he can sell them through a commission merchant or wholesale dealer in the city or cities to which his locality is tributary.

In this work larger areas of land are required. From 1 to 5 acres will answer the purpose, but for a larger business 10 acres or even as many as 20 acres may be necessary. The nature and character of the soil play an important part, and the grower should be in a situation to control the soil so far as possible; that is, he should not be so placed as to have to purchase his soil, which is an expensive item in itself, as this takes out of his hands to a certain extent the possibility of controlling conditions. In the growth of such crops a quick, early maturing soil is absolutely essential. By this is meant a soil readily adaptable to cultivation, that contains comparatively little clay, and that holds moisture readily and yet dries out quickly; in other words, a good, rich garden loam. The soil under glass must be changed every year and sometimes more than once a year. It is essential, therefore, to have opportunities for replenishing the soil without too much expense. The chief crops that may be grown are lettuce, cucumbers, and tomatoes. As incidental crops, mushrooms, beets, dandelions, cauliflowers, etc., may be used. Lettuce and cucumbers, however, constitute nine tenths of the crops that are grown in this way, and, all things considered, are more profitable than anything else in this field.

In beginning a work of this nature it is essential to consider the fact that when a start is made it will have to be on such a scale as to enable the grower to produce crops not only of good quality, but in sufficient quantity to pay a dealer to handle them. This is especially true if the grower depends on commission merchants or wholesale dealers to market his products. The first essential is to grow good crops; the second is to produce them in such quantities that the demand when once created will not fail for lack of supply. Many beginners make the fatal mistake of starting in such a way that they can not develop a good business for the reason that the supply of their product is not constant. The commission merchant or the wholesale dealer depends on a constant supply to build up his trade, and if he can not depend on the grower, he, of course, can not afford to give as high prices as where the quantity to be had is constant. Lettuce, for example, is grown under glass usually from October until March, three

crops being produced in this time. The first crop should be on the market by Thanksgiving day or earlier, and there should be a steady supply through the rest of the season until the middle of March. If the grower, having produced a good product, has found a ready market for it, he will lose it if for any reason his supply stops for a week or ten days or two weeks during the actual season of demand. This will hold true for all other crops.

To start in work of this kind on the basis of five acres would require something like the following as an outlay:

Five acres of land, at $250 per acre	$1,250
One greenhouse, 20 by 100 feet	1,200
Hotbed, sash, and miscellaneous equipment	550
Total	$3,000

The intelligent grower, conducting his work in a proper manner, planning well and using good business methods, should be able to secure from this amount of land and glass a gross income of from $2,000 to $3,000 annually, or a net income of from $1,500 to $2,000.

Cut flower growing is the most profitable field in the growing of plants under glass. It is most profitable for the reason that there is a greater demand for cut flowers than for vegetables, and while the risks in some cases are greater the profits are correspondingly large. The work in this field may be of two kinds—the growing of mixed crops, or specialization with one crop alone. By mixed crops is meant the growing of three or more crops of flowers, such as roses, carnations, violets, and chrysanthemums. In this field the best openings are to be found near cities with a population of from 10,000 to 50,000. There is always a demand in cities of this size for cut flowers, and this demand is frequently increased if there are any special institutions in or near such cities, such as colleges, universities, etc.

The grower here may either handle his own products or sell direct to dealers in the cities. It is more profitable, if capital can be secured, to handle one's own products. A store in the town or city eliminates the middleman and enables the grower to take not only the profits from the growing of his

crops, but the commissions which must be paid for selling the flowers as well. These usually represent about 100 per cent. In other words, the crops which the grower sells to the retailer in the city are sold by the latter at about 100 per cent advance over the prices paid to the grower. Considering the extra expense of store rent, clerk hire, etc., a considerable portion of this profit may just as well be secured by the grower, if he has the business capacity and can manage the details connected with both the city department and the producing department.

Moreover, this field offers opportunities for those who for various reasons can not obtain sufficient ground very near to a city. In other words, flowers such as have been mentioned grown under glass may be shipped with perfect safety from 50 to 300 miles, thus broadening the field of the prospective grower. This makes it practicable to secure land at very reasonable prices; but in addition to this must be considered the extra expense of express and freight rates both in the transportation of the crops produced and in the transportation of the material actually required for the work, such as fuel, manure, etc. Ordinarily, however, many choice locations can be found in the vicinity of a city where half an acre or an acre of ground can be secured at a price of from $250 to $500 per acre. It is not always practicable, however, to secure land as reasonably as this; more often, half an acre of such land will cost $500. Starting with such an area of land, three houses may be constructed, each at a cost of $1,000. In these may be grown roses, carnations, and violets. In this connection it is necessary to emphasize the fact that these crops can not be successfully grown all in the same house. Each requires a special temperature and special treatment, and hence the necessity for division of labor. With the land costing $500, three houses, $3,000, general equipment, $500, and a home for the grower costing at least $1,000, we have an investment of $5,000. The gross income from such a place should be at least from $3,000 to $3,500 annually and the net income from $1,800 to $2,000. If such an establishment is rightly planned in the beginning, it may be extended until the entire half acre is covered with glass. In such an event, of course, the grower will have to depend entirely on the out-

side for his soil, and manure, but this is not a difficult problem in the vicinity of a city. The gross income from such an establishment should be from $10,000 to $12,000 and the net income from $3,500 to $4,000.

Specialization in this field will be conducted in about the same manner as already described, except that the grower will limit himself to one crop, such as roses, carnations, or violets. There are some advantages in this and some disadvantages. The advantages arise chiefly from the fact that it seldom happens that all three crops fail in one season, while it sometimes occurs that one crop, for reasons which can not well be controlled, either falls off materially or else fails completely. A complete failure, however, is or should be very infrequent unless through bad management or lack of knowledge on the part of the grower. Specialization offers opportunities for growing crops of the highest quality and for competing in the market for the very best prices. The cost of such work is practically about the same as for general flower growing, already described. The opportunities, however, are more restricted for the reason that to compete in this field one must grow the very best material. In other words, to be a specialist means the growing of the very best of crops. To be a specialist, furthermore, means certain knowledge and a certain temperament which are difficult to find. The general gardener, or one who has been trained in the growing of a number of crops, very frequently fails when he attempts to specialize, because he knows too much about too many things to make a good specialist. Some of the best specialists in violet growing are men who have known little or nothing about growing any other crops, and have gone into the business from the workshop or from the farm. Going into business in this way the prospective grower has no preconceived ideas or notions about how the crops ought to be handled; his whole mind is centered on one thing, and he is not carried away by suggestions coming to him as the result of former experience in producing other crops. What is stated here in regard to the owner is applicable, of course, to the men whom the owner must secure for his help. Given a bright, quick-witted young man, with no prejudiced views

as to the growing of crops, he will in most cases make a better specialist than one who has had considerable training in general gardening work.

The growing of bedding and ornamental plants as a specialty is a field which is comparatively limited. The great improvement in transportation facilities has made it practicable to ship plants long distances; hence these plants are now turned out very cheaply and by the million in large establishments remote from the points where they are to be sold. Such being the case, the opportunities for the small specialist are few and are growing fewer. If the field is entered at all, it should be considered mainly from the standpoint of getting into touch with some already existing large establishment with a view to obtaining experience and with the ultimate view of pushing the business to such a point that large shipping facilities may be developed.

THE RECLAMATION OF THE WEST.

BY F. H. NEWELL.

[Frederick Haynes Newell, chief hydrographer U. S. Geological survey since 1888; born Bradford, Pa., March 5, 1862; educated at Needham, Mass.; graduated from Massachusetts Institute of Technology, as geologist and mining engineer, 1885; engaged in mining in Colorado; assistant Ohio geological survey; did miscellaneous engineering in Pennsylvania, Virginia, and other states; secretary National geological society, 1892–3, 1897–9; secretary American Forestry association since 1895; now chief engineer United States reclamation service. Author: The Public Lands of the United States, Irrigation in the United States, etc.]

Congress in the spring of 1902, following the recommendations of President Roosevelt, in his first message, took up the matter of the reclamation of the west, and June 17, a day celebrated in American history, signed the bill known as the reclamation law, setting aside the proceeds from the disposal of public lands in thirteen western states and three territories, for the construction of irrigation works. At that time the matter attracted little attention other than from those who were interested in the question. It was believed to be simply a western scheme which had been successfully lobbied through against the opposition of the leaders of both parties. As time has gone on the people have begun to appreciate more and more the importance of the law, not only to the west but to the country as a whole. It is now appreciated that if that law is well administered it will mean much to the future development of our country, and a complete change in some physical and economic features.

As citizens of the United States we are interested in seeing that every resource is put to its best use, and that the country is developed to its fullest extent. The object of the reclamation law is primarily to put the public domain into the hands of small landowners—men who live upon the land, support themselves, and make prosperous homes. At the same time this is to be done in such a way that it will not become a burden to the taxpayers.

The money for the reclamation fund is from the disposal of public lands in the west. This money is returned to the fund by repayment by the persons who are directly bene-

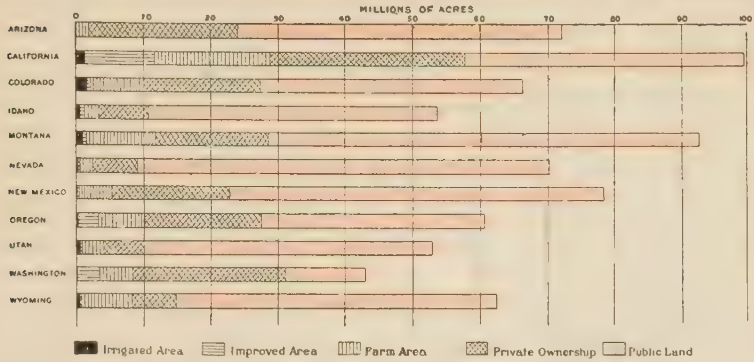
fited. This matter of refunding is one of the most essential features of the law. Many regarded this provision as trivial, but the more the effect of the law is studied the more thoroughly it is demonstrated that this repayment is one of the best safeguards of the law, keeping the administration clean and business like. The requirement that each project must be worth what it costs is a safeguard both in public and private undertakings.

Attacks upon the law have been made under the misconception that the eastern farmer is taxed to make western farms valuable, and that the government will be victimized by the lands passing into the hands of great corporations. These attacks would not be made if the men who utter them would read the law. It is carefully guarded in every respect, putting the lands into the hands of small owners and refunding to the treasury the cost of reclaiming the land.

This matter of irrigation and of western reclamation is by no means new. John Wesley Powell, in his early years, made extensive explorations in the west, studying its topography, geography, geology, and ethnology. In the course of those researches he became impressed with the opportunities for development of this arid land. His report, written in 1876, is still one of the classics to which all refer. The reclamation law is short and quickly read; its terms are general and it commits to executive discretion nearly all of the details which make a law a success or a failure. It sets up a few large and important safeguards, and says in effect to the secretary of the interior, "Here is this money; take it and spend it for this purpose; get it back in the treasury and do the best you can with it." That is unquestionably the ideal condition, and the men who are working under it must make it a success. They have no excuse for a failure. Congress has been liberal, has given the secretary wide discretion, and we have no apparent excuse for not obtaining the best results which the conditions will permit.

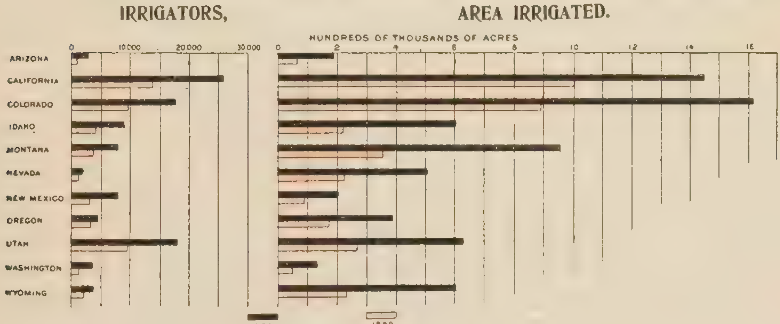
The secretary of the interior, to whom the whole matter is committed, decided to put it in the hands of Charles D. Walcott, director of the United States geological survey. He in turn is assisted by several men who since 1888 have

RELATIVE SIZE OF THE ELEVEN ARID STATES AND TERRITORIES WITH PROPORTION IN PUBLIC LAND, PRIVATE OWNERSHIP, FARM AREA, IMPROVED LAND, AND IRRIGATED ACREAGE.

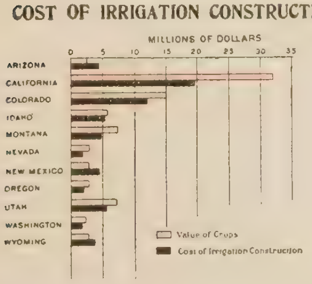


COMPARISON OF NUMBER OF IRRIGATORS AND AREA IRRIGATED, 1899 AND 1889.

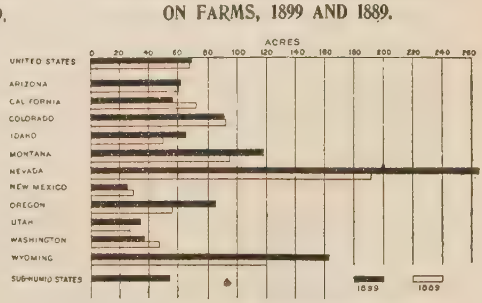
IRRIGATORS, AREA IRRIGATED.



COMPARISON OF VALUE OF CROPS AND COST OF IRRIGATION CONSTRUCTION, 1899.



AVERAGE AREA OF IRRIGATED LAND ON FARMS, 1899 AND 1889.



Sub-humid States are Kans., Nebr., N.Dak., Okla., S.Dak. and Texas.

been measuring the streams of the west, studying the water supply, and making an examination to ascertain how the lands can be reclaimed by irrigation.

The geological survey has for years been making a topographic map of the United States, and on that map are shown the streams, the reservoir sites in or near the mountains, and many other facts which are essential. In addition to the topographic branch, the hydrographic division has been measuring the waters which may be used or stored in these reservoirs. The work extends over thirteen states and three territories.

The problems are not merely those of engineering and constructing great works. It is not sufficient to build canals and bring the water where the people can get it; but, more than this, there are an infinitude of problems to be solved, and great tact must be used with the people. When it comes to the question of dealing with water, men may be good citizens, but they cannot be implicitly trusted when it comes to the question of water distribution.

The public lands are of many kinds, from densely forested areas extending far up on the slopes of the highest mountains of the Rockies down to the vast low plains and wide spreading, trackless deserts. Particular interest is attached to these high mountains and the forested slopes, for upon these depend to a large extent the future prosperity and the utilization of the agricultural lands of the west.

In northern California and along the Pacific coast in western Oregon and Washington are the greatest forests remaining in the United States. Around the Yellowstone National park and in the Rocky mountain region in general are more important forests. In considering any question concerning the forests we must bear in mind that the word forest comprises a great variety of tree growth. In the east it usually means a dense growth. Out in Colorado or Wyoming you can sometimes see a half mile through what is sometimes called a forest. A little scrubby growth of cedar or piñon may have great value to the pioneer, although it is not merchantable timber. These small trees furnish the poles and the posts which are so necessary to the settler. Even

the small bushes and dwarfed junipers or mesquite may supply the fuel which he must have for his home.

On the eastern edge the settlements gradually thin out in western Nebraska, western Kansas, and eastern Colorado. Here is a vast extent of fertile but dry country, where much of the land is in public ownership and the remainder is held largely by mortgage or loan companies in the east. This wonderfully attractive and in many ways rich country may be called the famine belt. In it many attempts have been made, in vain, to secure permanent settlement, and thousands of industrious and hard working settlers have been forced to leave by starvation. This is due to the fact that the rains are erratic, and, on an average, are just sufficient to produce good crops. In one year, or series of years, large crops may be raised, and the report is widely spread that here is the promised land; no sooner has settlement been established than the rains decrease slightly, or come at the wrong season, crops are lost, and the settlers are forced to migrate.

The area of land which can be reclaimed by irrigation is relatively small. If two or three per cent of the vast extent of arid lands of the United States are ultimately reclaimed and put under cultivation it will mean a population in the western half of the United States almost as great as that now in the eastern half of the country. The comparatively regular distribution of irrigable lands in each state is notable. The entire extent of irrigation development in each state is, of course, very small, but the proceeds from the small irrigated area in Colorado are already greater than from the mines.

The vacant lands of the arid west may be considered under three categories: The irrigable land, which always will be relatively insignificant as regards area, but of first importance as to values; forested areas where the land has relatively little value for agriculture, but is of greater importance in producing perpetual crops of wood or timber, and in protecting the water supply—this area comprises probably from 10 to 20 per cent of the arid west; the great body of arid land which would be productive with water, but for

which an adequate supply can never be had—this includes 80 per cent of the entire west, and is commonly spoken of as desert, although nearly every acre has some value for stock raising purposes at one time or another.

The irrigable land is being utilized through individual or corporate enterprise, and through the reclamation law. The forested areas are being protected by the activities of the bureau of forestry, but there remain the great tracts of grazing lands whose proper handling and control is still a matter of doubt.

A thorough knowledge of the location, extent, and capabilities of this vast grazing area must be had, and on the basis of this knowledge wise statesmanship must be shown in either holding this land perpetually, under suitable regulations, as an open commons for grazing or of disposing of it to individuals in such a way as to form permanent settlements and to create the largest number of homes. The grazing problem is the third and last of the great public land questions, the one which is still unsolved, and which, when satisfactorily settled, will lead to increased prosperity for the entire country.

The reclamation fund comes from the disposal of lands in 13 states and 3 territories, and the amount is widely different in the different states. The law provides that so far as practicable the amount shall be spent in the state where it originates, but in fact the available funds are almost always inversely apportioned to the needs of any one state. From Nevada, the state having the largest opportunity for development, the amount of money is represented by a small amount, while from North Dakota there has come an enormous fund. In the latter state there is little possibility of general development by irrigation because of the difficulty of finding irrigable lands and an adequate water supply. North Dakota and Oregon and Oklahoma have large funds. In Oklahoma, with its subhumid climate, there is little need of irrigation, and in fact it is almost impossible to find any reclamation project of considerable magnitude in that territory.

Examinations leading to construction are being carried on widely. At the points where dams may be erected for

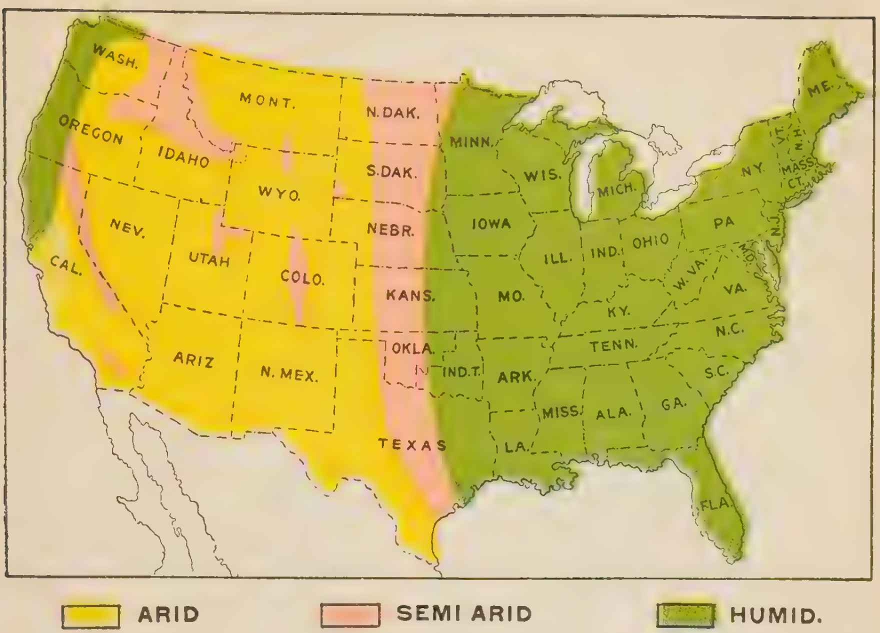
water storage the foundations must be studied, and for this purpose diamond drills are used to ascertain the character of the bed rock. Work of construction has been begun in two localities—one in Nevada and the other in Arizona. In Nevada the work in hand is that on a canal to take water from Truckee river into lower Carson reservoir site. Lake Tahoe, at the head of the Truckee river, is the highest large lake in the United States and in many respects is an ideal reservoir site, and its waters, if wisely used, will go far to promote the prosperity of Nevada.

In California, over the state line from Nevada, are opportunities for water storage. In the mountains are little valleys in which water can be held. It is impossible for Nevada, as a state, to utilize these reservoir sites, as it can not go across the state line. The national government is alone capable of doing this work. A dam put across Carson river near its lower end will flood back the water and make an immense reservoir capable of supplying several hundred thousand acres of land which is now absolutely desert and almost impossible to cross.

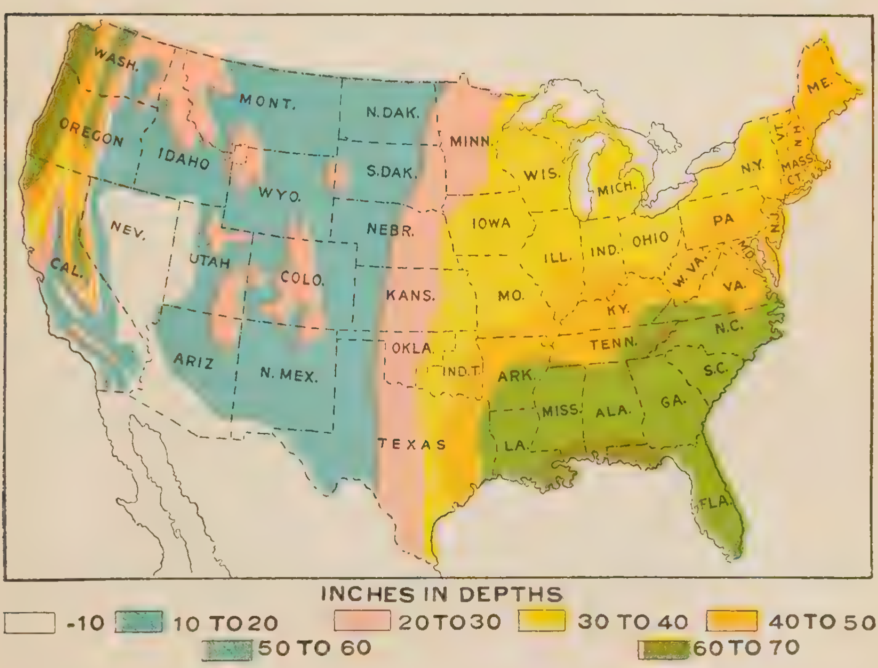
The interstate character of these problems of reclamation is exceedingly complicated, and is held as one of the reasons for federal intervention in reclamation, as well as the fact of federal ownership of the vacant lands.

In Colorado the largest project now in construction is that of taking the Gunnison river into the Uncompahgre valley. This river flows in a narrow canyon 2,000 feet deep. This canyon has been regarded as impassable, but A. L. Fellows, one of the engineers of the reclamation service, and an assistant went through in 1902 at the risk of their lives. The attempt had been made a number of times to go down it by boats, but without success. These men did it by means of swimming and by using a pneumatic mattress or rubber bed as a raft. In ten days, by floating, swimming, and climbing, they succeeded in getting through and locating the point at which was placed the headworks to take the water out by a tunnel into Uncompahgre valley. The tunnel, heading in the steep cliffs, passes under the mountain to the valley beyond, a distance of nearly 5 miles.

ARID, SEMI-ARID, AND HUMID REGIONS OF THE U. S.



MEAN ANNUAL RAINFALL IN THE UNITED STATES



Another project which has been under examination is that in southern Wyoming on the North Platte river, at what is known as the Devils Gate, on Sweetwater river, a short distance above the point where it enters North Platte river.

In northern Wyoming there is another reclamation project, that on Shoshone river, which here flows through a granite range. Surveys are being made to demonstrate the practicability of diverting this river and carrying it out to the broad plains of the Big Horn basin east of the town of Cody.

One of the greatest works in the United States is the utilization of the great Colorado river of the west. The headwaters come from Wyoming and Colorado, flow through Utah and northern Arizona, and the river finally enters the gulf of California. Along this stream are lands capable of high cultivation, as the soil is rich and the climate semitropical. The rank growth on the bottom lands shows that wherever water is found the vegetation is extremely dense. The river itself is constantly changing, shifting over a very broad channel. There is one point where it will be possible to build dams similar to those built by the British engineers on the Nile. The river, although a quarter or a half mile wide above, here becomes narrow, hardly wide enough for a steamer to pass, and at this point it would be possible to erect dams holding back the water.

Another project under consideration is in Arizona, on Salt river. This dam, if constructed, will be one of the greatest in the world, being 230 feet from foundation to top. The lands to be reclaimed along the Salt river are in the vicinity of Phœnix and are capable of a high degree of cultivation, producing crop after crop throughout the year. There are sometimes as many as seven crops a year raised.

In southern Idaho are vast tracts of desert land, to which water may be brought from Snake river. At the head of this river is Jackson lake, situated at the foot of the Grand Tetons. By closing the outlet of this lake all the water can be held, storing a sufficient supply for tens of thousands of acres along Snake river, in Idaho. In a portion of the course of Snake river in southern Idaho it has been found practicable

to divert the water upon vast tracts of fertile, level land. Near the railroad station of Minidoka, it is proposed to build across Snake river a substantial masonry dam and take out water on both sides with gravity canals, irrigating the sage-brush covered plains. A large amount of water can be allowed to pass through or over the dam, and it is proposed to generate power, utilizing this to pump water to some of the higher lying tracts which can not be reached by gravity.

A great project under consideration is that of taking water out of some of the tributaries of the Columbia. Millions of acres susceptible of irrigation are below the level of the headwaters of Columbia river, but in order to convey these waters to the dry lands it is necessary to traverse mile after mile of steep side slopes. The cost of the project runs up into the millions of dollars; so that while the government may execute it in the future, the project of reclaiming the great arid lands of the state of Washington is one which is almost impossible for the present time.

In the region of the Black Hills of South Dakota and Wyoming are numerous small projects.

In New Mexico the problems of reclamation are quite difficult, owing to the character of water supply and the large extent of the old Spanish land grants, taking in much of the best land of the territory. The principal stream is the Rio Grande, a perennial river in the northern part of the territory, but in the southern part a dry, sandy channel throughout much of the year. Its waters must be stored, and to do this problems of silt must be successfully solved. In the eastern part of the territory is Pecos river, flowing through a vast extent of country underlaid in part by soluble gypsum, and here the construction of storage reservoirs is rendered difficult by the waters percolating through the gypsum and finding channels of escape through underground passages.

In Utah, the central state of the arid region where irrigation development has proceeded very rapidly, the problems are extensive and far reaching. Utah lake seems to offer the greatest opportunity, for in this broad, shallow depression, four or five times as much water is lost by evaporation as is utilized in cultivating the soil. By reducing the area of this

lake the extent of cultivated lands may be accordingly increased. Bear lake, also on the northern boundary of the state, affords similar opportunities for conserving water.

In the far northern part of the arid region, in Montana, in the broad valley of Milk river, are opportunities of storing the short, intermittent floods of that stream. It is proposed to re-enforce these, if practicable, by water held in the glacial lakes at the foot of the Rocky mountains and put to use the streams which now flow northerly into Canada.

In Oregon, the Umatilla river, which flows into Columbia river, may be utilized by the construction of a large canal, catching its floods and taking them out into suitable basins where they can be held until they are needed on the broad extent of arid land south of Colorado river. In the eastern part of the state, on the Malheur river, are other localities where the floods may be stored and where thousands of acres of arid land can be converted into small farms sufficient to support a family in comfort.

The theory of reclamation is to conserve the flood waters that otherwise go to waste and hold them until such time as they are needed. There remains in the various states a vast extent of arid lands to which the flood waters can be carried and which, when watered, is capable of producing large crops and furnishing homes for prosperous farmers.

Irrigation properly conducted means intensive farming, the cultivation of the soil in the best possible manner, and diversified crops. The area which any one man can cultivate under such conditions is far less and the yield per acre correspondingly greater. In the best irrigated regions farms are very small, the average size of cultivated area in Utah being less than 30 acres. Small farms and the economy which must be practiced in conveying water results in comparatively dense rural population. In southern California the irrigated tracts in orchards and vineyards are so small that the farming region takes on the appearance of suburban communities. The houses, instead of being a mile apart, as on the prairies and plains of the central part of the country, are within a few rods of one another. Social intercourse is possi-

ble, good roads are assured, and rapid communication through electric car lines.

Cultivation of arid lands by means of irrigation results in a far higher type of civilization than is possible on isolated and lonely farms. Diversified agriculture, the raising of vegetables and small fruits, and the keeping of various domestic animals also necessitate greater mental as well as physical activity, continuous employment for all members of a family, and many minor industries impossible where attention is concentrated upon a single crop, such as wheat, corn, or cotton.

The small farms so successful under irrigation make possible a colony life such as that practiced by the Mormons in Utah and exemplified in the early history of the Greeley colony of Colorado. The success attained has led to a most interesting experiment, that of the Salvation army helping the people to get back to the soil. In their work in big cities the Salvation army has come across almost innumerable men and women who are eager for an opportunity to get away and start life anew in the open air. Out of the thousands of applications there have been selected certain families apparently best qualified for success, and these have been located upon small irrigable farms. Nothing is actually given these people outright except the opportunity to help themselves. They are sold a tract of land and a small house, necessary tools, and seed upon credit, and are given a reasonable time to repay the loan thus made, with interest. From one aspect the enterprise might be regarded as money making, but from the higher standpoint it is one of the greatest philanthropies yet undertaken.

This work of the Salvation army in establishing colonies in Colorado and in California is really more than an experiment, for sufficient time has elapsed to give it trial, and its success may be considered as demonstrated—sufficiently, at least, to justify further and larger efforts along this line. It is not believed that the submerged tenth can be lifted bodily and put upon the land to become successful farmers, but the weight of humanity above this tenth, the keen struggle of those a little better off, helps to submerge the despairing portion of the community and to obstruct every avenue of

escape. Relief from the congested conditions of the cities can come, in part at least, through furnishing opportunities for those who are able to go out upon the land and to become independent landowners and citizens. Ordinary farming can not offer any attraction to these people, who have spent much of their lives in the cities, as they are largely dependent upon keeping in crowds. The small farm and the suburban life possible under irrigation alone make it possible for such people to leave the city environment and become tillers of the soil.

To sum up the problem, we may say that we have a vast extent of vacant public land of wonderful fertility; we have water which will make a portion of this productive; we have the people who are seeking an opportunity to make a living, and who would gladly escape from the congestion of the cities; and we have the public funds and the public interest toward developing our country to the highest degree; but we are a long way from bringing these powerful forces to effective action. We are allowing the lands so necessary to the development of the nation to drift out of its control; we are allowing the waters and the opportunities to conserve them to be monopolized and become subject for speculation; and we are allowing barriers to be gradually erected shutting off the opportunities for development of our great internal resources.

FEDERATION OF RURAL SOCIAL FORCES.

BY KENYON L. BUTTERFIELD.

[Kenyon L. Butterfield, educator; he is at present president of the Rhode Island College of Agriculture and Mechanic Arts; he was a member of the faculty of the University of Michigan before he became head of the Rhode Island institution; he has been a frequent contributor to the leading magazines and reviews and has been especially active in the movement for the improvement of educational facilities among farmers as well as in the education of students in agricultural institutions.]

There is at present in America, a new interest in rural affairs. Especially are economic and social aspects of agriculture receiving more attention than for many years before. It may be that so far as this interest is manifested in the multiplication of magazine articles and newspaper editorials dealing with rural questions, it is transient—merely a passing fad. But without doubt there is coming to be a genuine and healthy interest, on the part of educated people, in the condition of American agriculturists. It is therefore pertinent for us to study such movements for betterment as already exist, and to plan if need be for broader work than has yet been done.

It is almost trite to assert the need of the socialization—to use a much worked phrase—of the country. It is possible that this need is not greater than in the cities, but it is different. Among no class of people is individualism so rampant as among farmers. For more than a century the American farmer led the freest possible social life. His independence was his glory. But when the day of coöperation dawned, he found himself out of tune with the movement, was disinclined to join the ranks of organized effort, and he prefers even yet his personal and local independence to the truer freedom which can be secured only through coöperative endeavor. Moreover, the social aspect of the rural problem is important not merely because the farmer is slow to coöperate. The real thesis underlying the argument of this paper is that the farm problem can be solved only through social agencies—agencies that shall adapt themselves to all the farmer's needs.

In discussing the topic, we must briefly review the social agencies now at work in rural communities before we can discuss intelligently the co-operation or federation of these forces. It would be a distinct blunder to suppose that such agencies do not already exist. Indeed, the so-called socialization of the country would be an almost hopeless task if it were not possible to build upon foundations already laid. It is no small cause for congratulation to those interested in this question that we have already under way a forward movement in rural social regeneration. It may be true that the agencies are not so progressive as we would wish, that in some ways they need renewed life and vigor, and that, more than all, there is need of a comprehensive plan of campaign. But the broadening and deepening of the work, rather than its initiation, is the task of practical sociology.

We may conveniently group the agencies already at work in rural life into the religious, the educational, the industrial. The religious forces comprise the work of the church, of the Sunday school, of the young people's societies, and the newly planned work of the Young Men's Christian association in country districts. The educational forces include not only the rural school, but also agencies for agricultural education, such as agricultural colleges, experiment stations, farmers' institutes, home reading courses for farmers, boards of agriculture, agricultural fairs, and the farm press. Under the industrial agencies we may name first of all the general organizations, such as the grange, the farmers' clubs, the National Farmers' congress, the Farmers' alliance, etc. These organizations have for their purpose the social and intellectual training of the farmer and the increasing of his influence in public affairs, with the idea of business co-operation somewhat incidental. In addition to these we find a multitude of co-operative societies among farmers whose sole purpose is that of business union.

It will be instructive to take even a brief survey of the work of these various social agencies.

Of the actual influence of religious institutions in country life, the general feeling is that the country church as com-

pared with the city church is not only falling behind, but is really in a sad plight. It is possible both to prove and successfully to deny this belief by illustrations, depending upon localities. But I do not think it is far from the truth to say that the country church to-day is relatively much less efficient than the city church. No doubt the country church still has a large conserving influence in rural life. There can also be no doubt that from the social standpoint, from the standpoint of the possibilities of service to the farm community, the country church as a whole has not yet begun even to grasp the idea of its mission. The work of the Sunday schools and of the young people's societies is rather more hopeful, for these bodies are relatively strong in the country. Of course, there are good reasons for the conditions of the country church. Most of the churches are very small. The pastorates give a bare subsistence, and offer few attractions to the majority of ministers. The man in the pew is conservative in mental attitude, cautious in plan, and not wealthy.

Along educational lines, the situation at present is somewhat brighter. The rural schools are severely criticised, and very justly, though personally I think some of this criticism is really more pertinent to the machinery than to the product. There is also this to be said, that the rural school question was never before such a live topic, not only among our educators, but among our farmers, as it is to-day. Whether the system of centralization, which seems to be the solution of the question, prevails or not, the prospects were never so hopeful as they are to-day for the substantial betterment of the rural school.

When we turn our attention to agricultural education proper, we find that while progress has been exceedingly slow, the situation was never so encouraging. We have in every state and territory an agricultural college, all of them magnificently endowed by the national government and receiving substantial aid from the states in which they are located. In these colleges there are many hundreds of young men studying scientific agriculture and preparing not only for teaching and research in science applied to the problems

of the farm, but also for actual management of farms. The splendid school of agriculture of the University of Minnesota is generally regarded as an example of the most successful work in secondary agricultural education, and as having pointed the way and led the movement for the solution of that extremely important question. In primary school work there is increasing evidence of the possibilities of teaching nature study or elementary agriculture in the rural schools, and there are successful examples of its introduction.

In research the United States department of agriculture and the experiment stations in each state and territory are employing hundreds of men and spending millions of dollars in seeking to discover the laws that govern plant and animal growth. In popular education of adult farmers, we find farmers' institutes in practically every state, holding thousands of meetings every winter and reaching hundreds of thousands of farmers with the best teaching that the day affords in the science and art of agriculture. We find successful examples of correspondence courses and reading courses. We find that the whole extension idea is taking root and promising a fruitage hitherto undreamed of. We find that though the glory of the agricultural fair has been dimmed, the fair still answers to a real need. The agricultural press is alert, well edited, and has an immense circulation.

On the side of organization, the situation is somewhat difficult to analyze. It has been said that the farmers of America are the only class not yet organized. This statement may be said to be relatively true and absolutely false. There is no one compact organization among the farmers. To perfect such an organization has been the dream of many a brilliant and self sacrificing agricultural leader. Such hopes have always been unrealized. Yet it is not true that farmers have not organized. Even the colossal failures in the organization of farmers must not blind us to the actual situation.

Let me illustrate with the grange. Thirty years ago the grange movement swept through the west with all the heat and rapidity of a prairie fire. It numbered its local

organizations by tens of thousands and its membership by millions. But the day of fierce burning passed by, the pace was too fast. The organization began to weaken, and it was not many years after its inauguration that students of our social movements said that the grange was dead. And they drew lessons from its demise about the difficulty of organizing farmers, about the foolishness of trying to solve grave economic questions by the dictum of the multitude, and so on. To-day the grange is not only a strong and most flourishing organization, but it has an influence and is performing a work the power and scope of which cannot be appreciated by those who do not know. There can be no less than 5,000 active granges, and there are not less than a third of a million active members. During the past ten years the membership has nearly doubled. In Michigan ten years ago there were about 8,000 active members; to-day there are 30,000. These local bodies meet perhaps semi-monthly. They serve to the farming community as a social club, a lyceum, a debating society, a citizens' league, a good government club, an educational association, and in fact almost any other purpose that adult citizens co-operate for. The power of the grange in legislature and congress is no small factor.

I speak of the grange as a type. Other organizations are doing much the same work. In respect to business co-operation, it may be said that while there is no one compact organization—and never will be—there is a vast amount of co-operation. It has been stated that there are no less than 5,000 co-operative societies of farmers. Practically all the fire insurance on farm buildings, representing a census valuation of over $3,500,000,000, is carried by farmers' mutual insurance companies. The co-operative efforts of the fruit growers of California and of the Chautauqua grape growers are well known. And while little has been done in proportion to the amount that might be done, business co-operation among farmers is in reality a large affair.

The institutions which we have just discussed, together with the improvement that comes from such physical agencies as assist quicker communication (good wagon roads, tele-

phones, rural mail delivery, electric roads), constitute the social forces that are to be depended upon in rural betterment. None can be spared or ignored. The function of each must be understood and its importance recognized. To imagine that substantial progress can result from the emphasis of any one agency to the exclusion of any other is a mistake. To assert this is not to quarrel with the statement we frequently hear nowadays that "the church should be the social and intellectual center of the neighborhood;" or that "the school should be the social and intellectual center of the neighborhood;" or that "the grange should be the social and intellectual center of the neighborhood." It is fortunate that these statements have been made. They show an appreciation of a function of these agencies that has been neglected. The first item in rural social progress is that the country preacher, the rural teacher, the country doctor, the country editor, the agricultural editor, the agricultural college professor, and especially the farmer himself, shall see the social need of the farm community. But to assert, for instance, that the church shall be the social center of that community may lead to a partial and even to a fanatical view of things. I would not restrain in the slightest the enthusiasm of any pastor who wants to make his church occupy a central position in community life, nor of the teacher who wants to bring her school into relation with all the economic and social life of the farm, nor of the leader of the farmers' organization who sees the good that may be done through the social and intellectual training which his organization can give. But if there is danger that the preacher in the pursuit of this ideal shall ignore the social function of the school and of the farmers' organization, or that the teacher, or the farmer, or anybody else who is interested, shall fail to see that there is a logical division of labor among rural social forces, and shall fail to see that it is only the intelligent and efficient and harmonious co-operation of all these forces that will insure the best progress, then to such I appeal with all the power at my command to recognize not only the breadth of the whole movement, but to appreciate the limitations of their own special interests. There are things that the church cannot do and should not

attempt to do. There are things that the school cannot do and should not attempt to do. Accepting our conventional division of social agencies, we may say that efficient rural progress stands upon a tripod of forces, and that balance can be maintained only when each is used in its proper measure.

We reach now the heart of the topic, which is how these various social forces may be brought into co-operation, a co-operation that is intelligent and real. I would suggest first of all the encouragement of all efforts along this line that are already under way. For instance, there are scattered all over this country individual pastors who are seeking to make their churches the social and intellectual beacon lights of the community. There are other individuals who are endeavoring to apply the social settlement idea to the needs of the country. There are associations which attempt to bring together the teachers and the school patrons for mutual discussion of educational topics; a good illustration of this is offered by the so-called Hesperia movement in Michigan, where a number of county associations of teachers and patrons are in operation. In numerous instances the farmers' organizations include in their membership the country pastor, the district school teacher, and perhaps the country doctor. In our own state of Michigan last year there was held a state conference based on this idea of federation in which the Michigan farmers' institutes, the Michigan Political Science association, the Agricultural college, and the university joined forces. It is expected that the superintendent of farmers' institutes will take the initiative in planning a series of county conferences along this line, as well as another state conference. The co-operation of the university, of the grange, and the farmers' clubs, of county teachers' associations, and of pastors' unions is anticipated. In these and doubtless in other ways the idea we are dealing with is being promulgated, and up to a certain point this fact of promiscuous initiative is entirely satisfactory and desirable. So long as the work is done it makes little difference who does it. Every attempt to bring any of these agencies into closer touch with the farm community is to be welcomed most heartily. But beyond a certain limit this promiscuous work must be unsatisfactory. The efforts and interests of

any one social agency are bound to be partial. Indeed, the more effective such an agency is, the more partial it is likely to be. Intensity is gained at the expense of breadth. The need for federation exists in the desirability of securing both the intensity and the breadth.

We come, then, to the final consideration, the form that this federation should take. In my judgment the need does not lie along the line of a new organization. What is chiefly necessary is a sort of clearing house for an exchange of ideas and plans among all who are at work on any phase of the rural social problem. There is need of a central bureau that shall emphasize the necessity of the study of agricultural economics and rural sociology, and press the value of co-operation in the work of social progress in the country. There is need that somewhere tab shall be kept on the whole rural social movement. We need a directing force to assure a comprehensive view and study of the whole rural problem. It is important that some investigations should be carried on that are not likely to be taken up by some other agency. It would be desirable to have a certain amount of publication, and in various other ways to carry on a campaign of education. Above all it would be desirable to initiate local, state, and national conferences pervaded by the spirit and purpose of securing the hearty co-operation of all rural social forces, of all the organizations that have any rural connection whatever, and of all individuals who have the slightest genuine interest in any phase of the farm problem.

Such a bureau should keep in constant touch with, secure the confidence of, and supply appropriate literature to, country teachers, preachers, editors, doctors, and business men, and, more than all, to intelligent and progressive farmers. And let me add at this point, that it must be fully understood that the work contemplated cannot possibly achieve large success unless it is done with the farmers rather than for the farmers. The problem is far from that of doing a missionary work for a downtrodden and ignorant class. It is a much less heroic, a much more commonplace task. It is simply carrying the idea of co-operation of individuals a step farther, and endeavoring to secure the co-operation of interests that have

precisely the same goal, although traveling upon different roads. The prime purpose of the movement is to secure breadth and wholeness, to assure well balanced effort, to bring the specialist into close touch with the more general phases of the problem.

COMMERCIAL FLORICULTURE.

BY LEROY THOMAS.

[Leroy Thomas, statistician; born in Wisconsin, December 17, 1874; graduated from the University of Wisconsin and later entered upon a journalistic career; he left an editorial position on the Superior (Wis.) Telegram to become connected with the Wisconsin state labor bureau and later went to Washington as an expert in the United States census bureau. The history and statistics of floriculture has been one of his specialities.]

Floriculture in the United States as a commercial enterprise is confined chiefly to the growing of flowers and plants in greenhouses. The industry originated in Philadelphia, and began to be of some importance about 1825. From 1830 to 1840 there was a rapid increase in the use of cut flowers and extensive improvements were made in the greenhouses. From that time until the present the demand for cut flowers and for palms, ferns, and decorative plants has grown even faster than the regular branches of agriculture, while the increase in wealth and population has so enlarged the florist's trade that it now gives employment, directly or indirectly, to thousands of men and women. Depending somewhat upon society and wealth for their patronage, the most modern and extensive establishments are located near the large cities, Philadelphia, Boston, New York, Washington, St. Louis, and Chicago being noteworthy points of distribution.

Many changes have occurred in the industry in the last twenty years, in the manner in which flowers and plants are put upon the market as well as in their culture. As in other lines of business, the trend has been toward specialization. The first step to this end was the establishment of retail stores in the cities, handling greenhouse products on commission, thus enabling the grower to devote his entire time to intensive production in the greenhouse, or to the exclusive growing of one kind of flower, thereby obtaining the maximum results in production and being able also to improve the product by

a thorough knowledge of the peculiarities and needs of the one flower selected as a specialty.

The choice of crops by the florist is largely influenced by changes in popular taste, the camellia, which was the most popular of flowers some years ago, having been superseded in recent years by the rose, carnation, violet, and chrysanthemum. A potent factor in promoting the flower trade has been flower shows, which stimulate public patronage and facilitate the introduction of new varieties. Among the flowers which recently have increased remarkably in popularity are lilies of the valley, the number now grown being from three to five times as great as it was a few years ago. This is due largely to the fact that these flowers are now on the market throughout the year, for by importing large quantities of pips and putting them in cold storage there is no difficulty in securing the flowers at any season by planting the bulbs in the greenhouses a few weeks before the flowers are wanted. The demand for orchids is also greater, having exceeded the market supply for years, notwithstanding a large increase each year in the number grown. One drawback to a still more rapid increase in the growing of orchids is the capital required in the original investment and the fact that when the crop is a failure it cannot be replaced easily by another. The growing of orchids is also limited by the need of experts, and by the large expenditures required for skilled labor to grow them.

The expense of putting flowers on the market is practically as great as the cost of their culture. The rent, express, messenger, and delivery charges, together with the wages of clerks and laborers, and the loss due to the perishable character of the goods, make it necessary for the retailer to almost double the wholesale cost of cut flowers in order to make a fair margin of profit, and it is upon this basis that the retailers and decorators buy stock from the growers. Since the wholesale value of floricultural products, as reported by the growers, is $18,422,522 for the United States, the retail value of these products can hardly be less than $30,000,000.

The annual income from cut flowers is estimated at $12,000,000 to $14,000,000. Upon this basis the sale of roses

averages $6,000,000 annually, with an annual production of 100,000,000. The carnation ranks next to the rose in popularity, with sales of $4,000,000, and an annual production of 100,000,000. The violet is third, with sales of $750,000, and an annual production of 75,000,000. The chrysanthemum sales equal $500,000, the season for the sale of this flower being short.

The modern greenhouse is an evolution from a simple beginning. Originally it was a place for storing or protecting plants during cold weather, and was heated by a stove. The first greenhouse on modern plans in this country was constructed in New York in 1764. Greenhouses were at first heated by flues or fermenting substances; in 1820 steam in closed circuits was introduced, and this was followed by hot water heating.

Most of the early houses had but little glass in the roofs, and the sides were built high in order to obtain all the sunlight possible, some having removable tops of sash. The introduction of fixed roofs into the construction of greenhouses marked a point from which advance was rapid.

Three systems of heating are in use—hot water under low pressure or in the open tank, hot water in closed circuits, and steam. The low pressure system is used more in conservatories than in commercial greenhouses. In locating a greenhouse, soil, nearness to market, shipping facilities, and the supply of water and fuel are to be taken into consideration. A number of greenhouses cover several acres, the land being plowed, as in the open field, and though the expense of cultivating is decreased, the number of flowers and plants grown is smaller than by hand cultivation. The output is less to the square foot than in smaller houses, while the cost of growing is proportionately lower.

Ten years ago the largest greenhouse range in the country covered less than 4 acres of land, while now there are a number of greater area near each of the most populous cities, a range near Chicago having 600,000 square feet, or about 14 acres of glass surface. The houses are built almost entirely of iron and glass. Until within a recent period all the glass used in greenhouses was imported from France and Belgium,

the American product having too many blisters to make it desirable. Now American natural gas made glass is used, to the exclusion of the foreign article. The size of the panes in the establishments has increased from 6 by 4 inches, as used in the primitive houses, to 16 by 20, and even larger in those of modern construction.

The large sale of flowerpots is one indication of the rapid increase in the number of greenhouses. Comparing the sales in 1869 and in 1894, the increase was tenfold; being, in round numbers, 700,000 flowerpots in the former year and 7,000,000 in the latter.

Forcing under glass was formerly confined to plants to be used for cut flowers, but the growing of vegetables and fruit in this way has developed into a remunerative industry, and long ranges of glass for this purpose are to be found in the vicinity of all large cities. In some instances the growing of vegetables and cut flowers is combined, but many large establishments are devoted entirely to growing vegetables, lettuce being the principal crop, while other vegetables forced are tomatoes, cucumbers, radishes, beans, and muskmelons. Of the fruits grown under glass, grapes receive the most attention, although an increasing quantity of other fruits is so matured each year. Vegetable hothouses yield an income of 25 to 50 cents for every square foot of bench room, the prices compared to corresponding open air products being five to one. Some gardeners start plants under glass and then transplant them to the field, cucumbers and tomatoes being grown in transplanting boxes to a size that will soon begin to bear. The ratio between the winter prices and those of products grown in this way is about two to one.

New York and Boston generally pay the highest prices for hothouse vegetables, but for vegetables which are not grown in their vicinity certain cities pay the New York price plus the express charges from the place. This is true of Chicago in the case of head lettuce.

A total of 96,230,420 square feet, or over 2,200 acres of land under glass was reported by 30,417 farms. There are 6,070 florists' establishments, having 68,030,666 square feet of glass surface, or about 51,023,000 square feet of land under glass.

In the eastern states, New York, Pennsylvania, New Jersey, and Massachusetts, where large quantities of vegetables are grown for the winter market, and where the florists' establishments are concentrated, the area under glass is larger than in any other section. Indiana and Illinois, in sections near Chicago, have extensive areas of land under glass for growing flowers and plants, and for forcing vegetables. In Virginia, land under glass was reported by farmers growing sweet potatoes. The sweet potatoes were started in hotbeds and the plants transferred to the field.

Many individuals in recent years have reported the growth of a few flowers and ornamental plants for the trade. Their product, however small, was included in the total of flower sales, but they were not included in the list of florists. On the same principle adopted in other branches of agriculture, the growers of flowers were separated into two classes, those making this enterprise incidental to agricultural operations, and those making it a principal business. If a person derived at least 40 per cent of his income from the sale of flowers and plants he was classed as a commercial florist, and his establishment was called a florist's establishment, or a flower and plant farm. There were 6,159 of these commercial florists in the United States. A large portion of the land reported by florists was improved. Over one half of the establishments have less than 3 acres, indicating that the land other than that under glass and occupied by buildings is a small improved tract. Of the total of 42,662 acres reported, 34,704 acres, or 81.3 per cent, are improved land. With 6,159 florists giving this total area, the average size of each establishment was 6.9 acres.

The total investment in land, buildings, and other improvements was $50,708,671. Owing to the large sum expended in the construction of greenhouses, the buildings and other improvements were valued at nearly as much as the land. The land value was also large, for many of the establishments are in or near cities and towns, where urban prices prevail. The investment in land was $28,024,715, and in buildings and other improvements, $22,683,956, while the value of implements was $1,366,887. The greater number

of establishments reported horses, and many kept cows for milk, but those reporting other classes of live stock were in the minority. The total investment in this line was $386,861.

The total product was $18,422,522, or an average of $2,991 for each florist. This included $17,377,860 of florists' products and $1,044,662 of miscellaneous farm products, all at wholesale prices. The retail value would be at least $30,000,000, since between grower and consumer there is sufficient expense and waste to nearly double the value. But a small fraction of the product was fed, florists usually buying the feed required for the small number of live stock kept. The value of products fed was $83,359. Although stable manure has always been the chief reliance for greenhouse crops, in most cases furnishing all the fertilizer desired, there were $316,038 worth of fertilizers purchased, largely manufactured preparations. The expenditure for labor was $4,155,979, or 22.6 per cent of the total value of products, showing a higher ratio among the florists than in most other lines of agriculture. Only in the large establishments was it necessary to have labor skilled in horticulture at wages beyond what is paid farm laborers.

In recent years there has been a steady downward tendency in the price of violets in the New York market. This is undoubtedly due mainly to the enormous increase in their production, which was fostered by the high prices prevalent a few years ago when the violet held a strong position in the favor of discriminating buyers, and also in a measure to the fertility of the Up-the-Hudson violet growing territory. Under the stimulus of high prices the inducement to build violet houses was strong, and the fact that they are still built in large numbers, indicates that prices below which growing would be unprofitable have not yet been reached. The Chicago market has not yet been subject to the strain of such an increased production as the New York market has experienced. The farmers of Virginia are now finding it profitable to grow violets in beds covered with cold sashes, exposed to the maximum of sunshine. The flowers are picked and shipped to the cities, and the sum realized from the sale of these by-products of the farm well repays the small amount

of labor necessary. The flowers are not so perfect or well developed as those grown in regular greenhouses, but are of good quality and are much cheaper than those sold by the retail florists. During the early spring, street venders with heaping trays of these violets, are to be found in the shopping districts and on busy corners.

The price of the lily of the valley and tulip shows an almost uniform descent in New York from year to year. This is accounted for, in part, by the fact that the market for these flowers has not been affected, as for roses and carnations, by the introduction of new fancy varieties.

The imports of bulbs, plants, and nursery stock into this country are a response to the growth of the florist and nursery industries, and at the same time point to a field for their further extension in growing here some of the stock now imported. The total value of bulbs, trees, plants, etc., imported during five years amounted to $4,388,003.

The number of farms reporting sales of flowers and plants was 8,799, the sales aggregating $18,759,464. Of these, 6,159 made a business of commercial floriculture and raised $17,377,860 worth of flowers and plants, or $2,822 each, leaving for the value of the product of the remaining 2,640 farms, $1,381,604, or an average of $523 per farm or establishment. This high average shows that most of these farms could also properly be called florists' establishments.

It is only within the last twenty or thirty years that the nursery has grown to be of sufficient importance to admit of its separation from miscellaneous farms in the compilation of statistics. Nursery stock was first grown as an adjunct to the general crops of the farm. It is difficult to determine when and by whom the first commercial nursery was established, but William Prince, of Flushing, Long Island, is named as pioneer in the industry. A catalogue issued by his son in 1825 has the following reference to the planting of this nursery:

"The Linnæan garden was commenced about the middle of the last century by William Prince, the father of the present proprietor, at a time when there were few or no establishments of the kind in the country. It originated from his rearing a few trees to ornament his grounds; but finding,

after the first efforts had been attended with success, that he could devote a portion of his lands more lucratively to their cultivation for sale than to other purposes, he commenced their cultivation more extensively, and shortly after published a catalogue, which at that early period contained several hundred species and varieties, and hence arose the first extensive fruit collection in America."

The large commercial nursery, however, similar to those of the present time, did not develop until the great orchard planting industry began in New York. Then it followed orchards and vineyards in extending west and south. In many of the western states the owners of large orchards propagate from the standard varieties they have on hand the stock they require in enlarging their acreage of fruit trees. This has not been taken into account in compiling the statistics of nurseries because the income from this labor would be credited to sale of fruit and not to sale of trees. The growth of the fruit business in this section, following the extension of irrigation, indicates a continuance of healthy development in nurseries. In America, trees are grown in wide, open orchards, upon a larger scale than in Europe, and the nurseryman aims to have straight rows of a uniform growth. Abroad they are trained to assume definite shapes, and in the same patch are grown conical and round head trees and bush specimens. A comparatively small amount of fertilizer is used by nurserymen, since their aim is to secure stock as hardy as possible for delivery to their customers.

More attention has been given lately to the ornamental branch of the business. Private grounds and parks, planted with numerous beautiful trees and shrubs, have helped the sale of nursery stock for ornamental planting. The modern methods and artistic work of landscape gardeners have also increased the sales along this line.

The opinion prevailed until recently that pear and cherry trees from eastern nurseries were to be preferred to those from other localities, but now the west grows stock equally good, and the south is also showing improvement in this line. By improved machinery, a better system of handling, and increased facilities and conveniences for shipping, the nurseries

have been enabled to extend their trade over a vast area. Nursery inspection, an American innovation, has assisted in extending the business. A number of states provide that nurseries shall be inspected at least once a year, and that copies of a certificate of inspection must accompany each order of stock shipped into or out of a state. This system has done much to prevent the spread of injurious insects and diseases, and also the sale of worthless stock.

Fifty years ago no municipality in the United States had purchased an acre of land for park purposes; to-day there are in the cities of over 50,000 population over 3,500 parks and squares with an area of over 60,000 acres. If the cities with a population of less than 50,000 are included, it is probably within the facts that the cities of the United States have 75,000 acres of land in parks and expend $11,000,000 annually for their improvement and maintenance.

The same standard is applied to the classification of nurseries as to florists; only establishments are given a place as nursery farms where nursery stock constitutes 40 per cent or more of the products. In 1900 there were 2,029 commercial nurseries in the United States. Within the past decade many small nurseries have been consolidated and numerous others have been absorbed by the larger companies. Many farmers sold nursery stock as one of the minor crops of the farms.

The total area in 1900 was 165,780 acres, with 137,459 acres, or 82.9 per cent, improved. The average size of the nursery establishments was 81.7 acres, although a number of 500-acre tracts were operated. The value of land, buildings, and other improvements was $18,144,073, the former value being $13,880,820 and the latter $4,263,253. The average value per acre of the land was $84. The value of buildings was much smaller for the nursery establishments than for the florists' establishments, and the value of live stock much larger. This is due to the fact that nursery operations are much the same as in other farming. The value of implements was $539,895 and of live stock, $462,013. The total value of products was $10,086,136, and $139,512 was expended for fertilizers and $2,305,270 for labor. One of the heaviest

expenses of the nursery growers was that for labor, the amount constituting 22.9 per cent of the value of the product, a much larger proportion than is involved in the raising of other crops, except flowers and plants. The total value of products comprised $9,231,503 from nursery stock and $854,-633 from general farm produce. Distributed among the 2,029 establishments reporting, it gives an average value of product of $4,971. The value of products fed was $192,999, a considerably larger proportion than for the florists.

SOUTHERN AGRICULTURE: ITS NEEDS AND CONDITIONS.

BY D. D. WALLACE, Ph. D.

[David Duncan Wallace, professor history and economics, Wofford college; born Columbia, S. C., May 23, 1874; graduated from Wofford college, 1894; took special studies in history, economics and English; post-graduate work at Vanderbilt university, 1894–6, 1898–9; taught in Carlisle fitting school of Wofford college, 1896–8; professor since 1899; Author of Constitutional History of South Carolina, etc.]

The south is one of the two great agricultural sections of the United States; the other is the great prairie region of the northwest, a little smaller than the south in area and a little larger in population. By the south is meant what is really the southeastern quarter of the country, skirted on the north by Pennsylvania, the Ohio river, Missouri and Kansas, and sweeping in a broad belt, with a length of about twice its breadth, from Delaware to Texas. The northern borderlands of this region differ so in population and products from the other states of the group that we shall count them only in making general statements, but never in citing illustrative examples.

The relative importance of the south in American agriculture is greater than seems to be recognized by the rest of the country, while it is doubtless less than her own people commonly assume. By comparing the two great agricultural sections of the United States, we discover that the farm property of the south comprises 43 per cent of the total farm acreage of the country, but only 41 per cent of all farm values; while she furnishes only $28\frac{7}{10}$ per cent of the total products. The value of farm products in the south, therefore, is low as compared with the acreage, and the value of farms is still lower. In the northwest, on the other hand, exactly the reverse is the case; that section comprises only 38 per cent of the total farm acreage of the country, but 56 per cent of all farm values and 50 per cent of all farm products. This disadvantageous comparison of the value and products of south-

ern farms is very largely accounted for by the fact that a much greater proportion of lands in that section is still uncultivated than is the case in the northwest. Yet when this has received its due allowance, the southern farmer and the southern statesman have many lessons to learn from the northwest as to progressive agriculture, both from the standpoint of the individual and from that of the commonwealth.

Georgia and Iowa may serve as typical examples of the greater productivity of the northwest. The two states are about equal in area and population; yet Iowa feeds her live stock annually all but as much as the total value of farm products in the state of Georgia; while the total value of all Iowa's farm products lacks only one third of one per cent of equaling the combined totals of Virginia, North Carolina, South Carolina, Georgia, and Florida. Only Texas can compare in the volume of her agricultural output with this banner state of the northwest, and even she falls short more than $135,580,000.

We must concede, therefore, that the south occupies the second place among the great geographical divisions of the country as a producer of agricultural wealth.

The condition of the southern farmer has immensely improved in the last ten years. To-day he stands, for the first time since the war of secession, in a position promising permanent betterment of his farming and of his social position. Until recent years three causes, any one of which was a fearful incubus, combined to pull him down, viz., low prices, the lien system and bad farming, including under this head poor management and antiquated methods.

Scarcely any impediment is heavier to bear up against than producing for a long term of years for a continuously falling market. Sir Guildford Molesworth estimates that between the years 1872 and 1894 the prices of general commodities fell 50 per cent; the price of wheat 60 per cent; that of cotton 70 per cent. In manufactures this depression of prices was in large measure offset by new inventions and economies in production; but the agriculturist, from the nature of his occupation, is almost entirely cut off from such retreats.

To add to the hardship of his salable commodity's constantly falling in price at a rate so rapid that we may say that the value of his cotton appreciably diminished even while the boll expanded, the southern farmer was drawn by circumstances into doing business under a system which subjected him to a ruinous usury and left him almost completely robbed of his freedom as to planting profitable or unprofitable crops. Along with the rest of the structure of southern industry, the war of secession shattered the system of agricultural credit. There was no longer a class of large planters possessed of valuable estates to whom banks of immense capital or wealthy factors stood ready to lend at fair interest. Ready money existed only in the traditions of the past; the southern farmer found himself without the means to buy even the seed to put into the ground. Then the crop lien law came to his assistance and remained to his destruction.

This system of industrial peonage known as the lien law works as follows: The farmer prepares in February for planting. He goes to the proprietor of an establishment, which in its typical form is a crude department store dealing in every article from medicines to wagons that he is likely to need in his simple existence. He requests the merchant to run him during the year, that is to say, to sell him supplies on credit until the crop is harvested. He promises the merchant to plant a certain acreage of cotton and signs a mortgage upon this yet unplanted crop. He is now at liberty to buy on credit from this particular merchant anything he requires; but he can not buy anywhere else, for he has no cash, and his credit and security are all pledged to his patron merchant. The merchant has two scales of prices, cash and credit, the latter much higher than the former, the excess constituting interest which the lien farmer must pay. With a few merchants the credit prices are scaled down each month, so that the rate of interest remains approximately the same on all goods purchased on lien; but ordinarily the prices remain unchanged up to the last day before settlement, so that the rate of interest rapidly increases as the time before settlement diminishes. On goods which the farmer gets late in the summer, he frequently pays interest above the cash price

at the rate of 200 per cent per annum. For the whole term of credit, extending from February to October, he pays on the average, in different localities, from 40 to 80 per cent per annum. The usury law forbids the bank to lend him money at a higher rate than 8 per cent, but protects him by allowing the merchant to charge him 200 per cent, on the principle, apparently, that a man may consent to pay any price he chooses for capital in the form of merchandise, but that he is not at liberty to offer more than a moderate price for capital in the form of money, no matter how badly he may need it or how great the benefit to be derived from its possession.

Some large merchants employ a sort of traveling inspector of securities, on whose report of the condition of each customer's crop the question of further advances is determined. Possibly by July the farmer has so much charged against him that the merchant considers it unsafe, in view of the uncertainty of seasons, to allow the crop to cover any further credits, and accordingly declares himself under the painful necessity of declining further sales except on additional security. The farmer then gives a mortgage on his slight furniture, bedding, cows, everything. The law does not allow him to give a mortgage on his wife and children.

Late in the summer the crop is sold. Not to lay the price upon the counter of the lien merchant is, in law, a misdemeanor; but in farming it is starvation for the next year—or at least, the farmer thinks so. Very commonly in good years, and as a general rule in bad ones, the price of the crop does not equal the amount on the merchant's books against the farmer. Sometimes the sheriff is called in to supply the deficit from the real and chattel additional security; but not generally. The lien, at least in some states, contains a clause requiring the farmer to enter into a similar agreement the next year with the deficit charged against him if he does not succeed in paying out the first year's account.

The iniquity of such a system is exceeded only by the suffering of the farmer under it. To observe its operation makes plain the ground for the biblical injunction given three thousand years ago to an agricultural people against usury. And the pathos of the lien farmer is that he is always only

twelve months from freedom. Better that he should eat but one coarse meal a day and wear his cheap clothes to the last frazzle of decency, and by one unremitted struggle break his chains.

This lien system goes far to account for the amazing fact a few years ago of the southern farmer's persistently planting a full acreage of cotton in the face of an already glutted market. Those who then berated him for his folly little understood his predicament. For the southern cotton farmer, cotton is the only money crop; but for it there is absolutely certain sale, for there exists from the field to the factory a market unexcelled for its thorough and sensitive organization in the commerce of the world. Government bonds can sooner fail of a purchaser than can a bale of cotton. When a lien merchant sells goods with cotton as security, he sells practically for gold paid in hand and by the same act invests his gold at an enormously profitable dividend. If cotton has fallen in price, the merchant requires the farmer to increase his acreage, as more bales are necessary to equal a given sum; and as the farmer's necessities do not diminish with the price of his product, he submits; and so we behold the paradox of men's planting more and more of a certain crop for the sole reason that to plant it is becoming less and less desirable.

The effect produced upon the character of a people by rack rent is well known; where the tenant promises a rent equaling or exceeding the surplus product of the land above what is necessary to keep him alive, he has no inducement to good farming, as the total surplus produced will be taken from him whether it be great or small. His fields present the most miserable appearance. The same is true of the farmer whose lien just suffices to secure on credit the bare necessities of food, clothing, and farming material. Not infrequently he even neglects to harvest his crop, and the merchant has to send his own men to pick it from the field.

The hard times from 1891 to 1896 were of incalculable benefit to many southern farmers. The terrible experience of usury, depressed prices and industrial peonage led many to resolve to be free from the lien system; and the enforced economy of those years taught how alone that resolution

might be realized, viz., by the accumulation of a certain reserve capital beyond the necessities of each day's living. To save one dollar is better than to earn ten. An indispensable prerequisite to the progress of any people is their learning, by self denial, to save from this year's consumption something of this year's product. Those farmers who learned this lesson have merged to a greater or less degree from the shackles of the usurious lien system, and in many instances what formerly went in 80 per cent interest to the advancing merchant is now drawing 4 per cent in the savings bank.

Some explanation is necessary of the southern people's continuing a system so bad. It is favored by a large class who could, by proper exertions, live without it, but whose indolence deters them from the supreme effort which would assure their ultimate prosperity; and by a still larger class, generally tenants, whose unfitness to manage farms would require them to become hired laborers if they could not get supplies in advance under the lien law. Thus the system is an evil in three ways: it puts land under the management of earth butchers who destroy the natural resources of the country and reduce its production of wealth; it leads men capable of better into a system of indolence, destroys their credit and self respect, and robs them of interest in their life work; and lastly, it proves a terrible master to the man who has once fallen into its subtle, tightening embrace, and who desires independence and progress.

The development of farm tenures in the south has been from simple to complex. Before the war the system of ownership was dominant; but within that there were two classes —owners who attended to their estates and owners who committed them to salaried managers. Managers, once so common, now operate less than one in a hundred farms in the south—a smaller proportion than in any other section of the union. A southern farmer who is sufficiently trustworthy to have extensive lands committed to his care will give his employer no rest until he consents to sell; or failing in that direction, he buys some old plantation whose proprietor family has either become extinct or moved away in their itching for town life.

The impoverishment of the large planters and the disorganization of the labor force by the war of secession necessitated large plantations being broken up into units sufficiently small to be operated on a limited capital and with a minimum of laborers. Between 1868 and 1873 in Georgia 32,824 small farms were thus created, and the same process was in operation throughout the south. Thus the immediate tendency of the war was to the distribution of the land in small tracts into more hands; and in this was cause for gratulation; for not only did it open immense new possibilities of social progress and industrial independence to thousands of white men whose lives had been one of woeful sacrifice to the slave worked plantation economy, the tragedy of whose wretched existence has never yet been written, but it was calculated vastly to increase the wealth of the country; for, to a point not yet reached in the United States, the productiveness of farms rises exactly as their acreage decreases.

But no sooner had the more enterprising of the southern population begun to succeed than the tendency to a wider distribution of land met a counter tendency towards the increase in the size of estates, doubly augmented by the prosperity of some and the misfortunes of others. It may be safely asserted that to-day the best type of southern farmer either owns a large estate, or is paying for tracts recently added to his plantation, or is expecting to make such additions. He has set a thousand acres as the goal of his ambition. In many localities this feeling has grown into such an insatiable land hunger on the part of wealthy planters as seriously to handicap young farmers who have not inherited property.

One bulwark protects, but not completely, the country from serious injury from this tendency: there are so many men with this same ambition and with the same chances for gratifying it.

The vast majority of southern farmers, 93½ per cent, are included in the three classes of owners, cash tenants and share tenants. Owners operate 47 per cent of the whole number of farms; cash tenants 17½ per cent, and share ten-

ants 29½ per cent. The desirability of these three classes is in the order of their enumeration, as is also their wealth producing capacity, even to a degree beyond what appears from glancing at the figures. It is the universal rule that small farms of any given tenure are more productive than large farms; so that when we consider that notwithstanding the fact that cash tenant farms are one third larger than share farms and owner operated farms are two and one third times larger than share farms, yet the productivity of owners and of cash tenants exceeds that of share tenants, while that of owners almost equals that of the much smaller cash tenanted farms, the relative superiority of the different forms of tenure is more thoroughly revealed.

TENURE, AREA AND PRODUCTIVITY OF SOUTHERN FARMS.

	Owners.	Cash Tenants.	Share Tenants.
Number of white farmers.	1,060,559	187,088	491,655
" " colored "	158,078	271,702	280,699
Total number of farmers.	1,218,637	458,790	772,354
Average acreage.	146.9	85.6	62.6
Percentage of all farms.	46.9	17.5	29.5
Percentage of total farm area.	49.5	10.6	13.7
Product per improved acre.	$10.44	$11.48	$10.29

Average size of farms operated by white farmers of all tenures, 173 A.
" " " " " " colored " " " " 53 A.

Share tenants, if they furnish implements, stock and feed, generally give the landlord from one fourth to one third of what they produce; if these are furnished by the landlord, he gets one half the gross product. These proportions sometimes vary in different sections and with different crops. It is simply what in Europe is known as metayer farming.

The status of the renting farmer and his landlord throughout the United States has occasioned some anxiety for the future of the American yeomanry. In the country at large the percentage of owners is appreciably larger than in the south, and both classes of tenants respectively are appreciably smaller; for of the total 5,737,372 American farmers 54.9 per cent own the farms they operate, as against 46.9 per cent in the south. It must be acceded in addition that the tenant system in the south is much more indicative of

evil consequences than in other sections. In the northwest, for example, the number of tenants is swelled largely by the sons of aged retired farmers in whom the titles still rest, and by enterprising men who have made the second step in the gradation of hired laborer, tenant, owner. This is true to a much less extent in the south. The tenant class there is composed mainly of shiftless whites who have definitely settled into what has come to be known as the tenant class and of earth butchering negroes. All the alertness of a landlord close at hand, who is himself strong willed and a good farmer, is required to save land from deterioration after several years under such tenancy. The safest method has been found to be for the landlord to retain the right to supervise authoritatively every detail of the farming, not only by specific stipulations in the contract, but continually during its execution. Absentee landlordism in the south means, almost inevitably, land butchery.

What is the tenant's chance to attain the ideal of farm life—ownership of the land upon which he works?

The southern farm tenant has the best opportunity of any renter in the world to become an independent proprietor. If, under the improved agricultural conditions which promise to continue, he does not enroll himself among the owners, it will rest as a heavy indictment against his worth of character.

Last year I was driving through one of the richest agricultural sections of the south. A place better fenced and kept than the ordinary impressed me. "That man was a tenant five years ago," said my companion. "He made a small cash payment on that $5,000 cotton and tobacco plantation; he lived hard for four or five years, and now he has paid the last cent of the price."

A few miles farther on stood a rusty hut of doll house dimensions, jammed up jealously against the railroad track. In the yard a woman of comely but unclean person washed clothes. The slouchy individual in blue shirt and no suspenders was her husband. Most likely neither of them could distinguish the English language in its printed form from the inscription on an Aztec monument. These tenants might

have bought a good farm for less than the clerk in the city would pay for his cottage home; for the average value of farms in the south is only $11.79 an acre, as against $36.25 for lands in the northwest frequently not so productive.

The dwellings and wages of southern farm laborers have both improved, the former in the greater degree. No progressive southern planter would to-day build such quarters as were erected twenty years ago. Experience indicates that good quarters attract a better type of laborer and hold him more steadily, and so prove a good investment. In some parts of Louisiana dwellings furnished to a family free of charge (as is throughout the south the universal rule) cost $400. Comfort is subserved in better floors, glass windows and secure ceiling; and decency, in a larger number of rooms.

The condition of the agricultural laborer seems to have improved most in the distinctly staple states, such as Louisiana, Alabama and South Carolina, rather than in those whose agricultural interests are scattering, such as Maryland and Kentucky.

Wages to the laborer are less in the south than in any other section; but there is ground for believing that the cost of labor is greater to the southern farmer than to the northern, western or northwestern.

One of the results of this inferior help is that the southern farmer enjoys but a small part of the benefits of agricultural inventions; first, because to hire the low priced labor is as cheap in the short run as to buy the machinery, and thus the pace is set at antiquated methods and non participation in agricultural progress in the long run; and second, because such ignorant labor can neither utilize nor take care of expensive machinery.

To understand the inferior quality of southern farm labor necessitates a brief examination of the personnel of the labor force. First, there are the white laborers, comprising something more or less than half the entire number of the actual tillers of the soil. It has been estimated by respectable authorities that the major portion of the cotton is raised by white labor; but concerning a statement of such

importance, I will only say, in the absence of positive proof, that it is not improbable. Certainly, far more of the hands that actually hold the plow are white than is popularly supposed. These laborers generally work for themselves or their parents; and as they do not ostensibly enter the labor market, their numerical importance goes unnoticed.

Secondly, there is the negro farm hand, who contributes the great bulk of the hired labor and is a sort of pacemaker to the white laborer.

I shall speak later of the better qualities of the negro; but at this point I must call attention to the widespread prevalence of certain evils which constitute a serious problem in southern agriculture. The generation of the race not yet sobered by middle age, who have never known on the one hand, the fine discipline of the antebellum masters, nor have yet, on the other hand, learned self discipline in the more trying conditions of freedom, have degenerated to a level lower than any occupied by their race since its African barbarity, and lower, let us hope, than it will ever occupy again. Not only the morals, but—what bears more directly on the present inquiry—the efficiency and reliability of the mass of the negro laborers below the age of forty are injured to a considerable degree by the group of vices represented by the pocket pistol, liquor, a deck of cards and a mistress. A certain dash of wildness marks youth under all colors; but such general statements are by no means adequate to cover the case of the postbellum southern negro.

Not only are the higher qualities of the laborer depending on character thus destroyed, but this moral degradation has necessarily incurred physical degeneration by initiating the negro into a catalogue of diseases to which his race was forty years ago a stranger. Some investigators assert something like 70 per cent of the race are infected with a dangerous type of disease incident to vice. And yet he works; for his constitution offers a strange resistance to a form of poison that completely invalids the white man, but frequently injures the negro no further than seriously to impair with lassitude and weakness that splendid body his inheritance by nature.

Not only is the negro, like all ignorant labor, inefficient, expensive, and unprogressive, but he is suited to only a few staple crops, to the culture of which he has been reared. The negro is an inveterate "cottontot" and conspires with the lien system to keep southern agriculture to that staple. His preference for cotton is shown by the fact that 71.9 per cent of the negro farmers of the south are cotton farmers, as against 28.5 per cent of the white farmers.

As a rule, not without some exceptions, those counties in the south which have a large negro population are inferior in productiveness to those of similar natural quality in which the negro population is small. The productiveness of the farms of white farmers, north and south, is, with rare exceptions, greater per cultivated acre than the productiveness of lands cultivated by negro farmers. The fairest basis of comparison is the productiveness of share farmers of the two races; for in this class practically all the management and all the labor are done by the farmer and his own family. Not only do the financial limitations and the small fields of share farmers preclude them from hiring labor, but whites will not work for negro farmers, nor will the negro, if he can avoid it, work for the small white farmer, and least of all for another man's "cropper." And, sad to say, thousands of white croppers are fully equal to the most benighted negroes in lack of education.

I am concerned with the negro only in his bearing upon the present condition of southern agriculture, and do not intend the dark pictures I have drawn of his shortcomings as views upon the race question. The best element of our colored people merit sincere praise for their progress; but it can not be denied that the great mass of the negro population, in its present condition, is a fearful incubus upon the industry of the south. To contend that the negro fills such a large part of our economy is not to prove his efficiency or his necessity; for ours is the only great country of the world that is not without his aid. The immediate need of the industry of the south regarding him, whatever his final destiny, is to strengthen his character and raise his intelligence to a point adequate to the proper performance of his economic functions.

Such is the machinery of southern agriculture; what does that machinery do? In the first place, it produces crops to the annual value of more than a billion and a third dollars, constituting 28.7 per cent of the agricultural output of the country. Two staples, cotton and corn, embrace 65½ per cent of all the crop values of the south, and only seven of her crops can be called in any sense leading, viz., in the order of their value, cotton, corn, fruits and vegetables, hay and forage, wheat, sugar yielding canes and rice. These comprise 91½ per cent of all her crop values. Corn has come to occupy a greater acreage than any other crop, having 25,612,949 acres as against 23,518,433 for cotton, which leads us to hope that King Cotton's disastrous tyranny has been tempered to the milder sway of a limited monarch.

The three cardinal needs of the southern farmer to-day are education, diversification and credit.

The fundamental failing of the education offered the southern farmer is that it is not adapted to the end in view. The curricula, past and present, of our schools hardly bear the evidence of being framed for a people whose prosperity depends so largely upon mastering the art and science of the tilling of the soil. The country schools should teach branches bearing upon agriculture, beginning with nature study with the little tots, and extending to physics, chemistry and botany for the mature pupils. Not only should the boy learn of the lovely lea, over which the lowing herd so slowly winds, but he should have an even more intimate acquaintance with the composition of the soil and of the physiology of those cattle. The present system of educating country children fits them for the spheres they are to fill little further than by such unfolding of the intellect as necessarily results from any schooling, but rather presents the anomaly of rearing a great people to unfitness for its life work. The curriculum of rural schools should be such that farmers would feel that they could not afford to allow their children to miss its benefits.

Many southern agricultural colleges meet the need little better and fail signally to send men back to the farm. In this respect a number of schools in the northwest excel ours.

The agricultural college of Michigan has sent a larger per cent of its graduates into farming than professional schools and universities send of their graduates into the professions for which they were prepared. The only plan of agricultural education which has succeeded in any state in its object is to have the institution devoted exclusively to preparing the farmer for his peculiar life work, and at very low expense. Agricultural colleges which give extensive courses in non agricultural branches are used simply by young men desiring the shortest cut, and hence an inferior preparation, to a professional career, and the real agricultural interests of the state in question remain almost completely untouched. The agricultural college in which the student can pursue a course largely non agricultural is a monstrosity, but, unhappily, not a curiosity.

Louisiana among southern states seems to have succeeded best in agricultural education, though she lacks much of a complete system. She has a number of schools distributed among sections of the state differing in soil, climate, topography and latitude, in which nothing but agricultural sciences and practical farm work are taught, and in which the sons of millionaire sugar planters, along with all others, are compelled to work, not to help pay their expenses, but in order to learn farming.

To urge the uneducated farmer to diversify crops is to make demands beyond his preparation. Tell him that it will render life more interesting, and you are talking into his deaf ear; inform him that it will preserve the fertility of the land, and he will not believe you; point out that though the fruit and vegetable crop is only 2 per cent of the acreage, it is 8.3 per cent of the value of all crops of the country, and he will forget it; remind him of the fact that his well to do neighbor plants cereals extensively, raises hogs and has a fine flock of sheep, and he will explain that his neighbor can do these things because he is rich, and will stubbornly decline the theory that his neighbor is rich, in part at least, because he does these things. Agricultural education brings agricultural diversification as inevitably as general education

produces diversity of professions, and nothing else ever can secure it.

And lastly the southern farmer needs better facilities for obtaining credit.

Figures for the whole south are not at hand, but those for the state of South Carolina indicate that banking capital is less abundant now than before the war of secession, notwithstanding the rapid multiplication of banks all over the south during the last ten years. The capital, surplus and circulation of banks in South Carolina to-day is $11,802,584, or $8.81 per capita; whereas in 1861 these items for the twenty banks then in existence aggregated $21,031,522, equaling $29.88 per capita; while in 1850 the per capita rate for the same items was $32.73. The disreputable character of much antebellum banking necessitates my stating that there was not a single bank failure in South Carolina from the revolution to 1861; her bankers won the commendation of the most exacting critics, and their notes passed everywhere for gold. Louisiana is another state with a very similar record.

These rich banks of the slavery régime lent principally to the large planters, on personal endorsement, stock and bond security, and real estate mortgage. Substantial factors also did an extensive lending business, in a way which made them a sort of predecessors of the modern lien merchant,. The factor advanced cash to the planter, secured sometimes by a real estate mortgage, and sometimes only by note, with the promise (not legally enforceable, however) that the crop should stand good for the debt if necessary, and that in any event the factor would enjoy the advantage of handling it. The bank then rediscounted, perhaps at a lower rate, the planter's note as endorsed by the factor. The step to the vampire lien system was made after the war, when the factor was replaced by men who similarly borrowed from the banks upon their mercantile expectations, but who made the handling of the farmer's cotton a subsidiary business, even if they engaged in it at all, and sold him goods at enormous credit prices on such lien security that many a lien merchant has never in any true sense lost a dollar by bad debts, but has

simply failed to collect to the extent of more than reasonable profits, instead of the higher ones he set as a standard.

The financial need of the south to-day is more banking capital in close touch with the farmer. Large city banks do not seek agricultural business; they dislike the farmer's business ways, the duration of loans to him, and the character of his security. It is true, however, that the farmer receives fairer treatment at any one of the several $100,000 banks in a large town than at the single very small bank in the very small town.

And rural banking facilities are wonderfully increasing. In several southern states ten years ago there were hardly a dozen banks. One thousand three hundred and seventy four of the 2,172 banks existing in the nine states of Alabama, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, Arkansas and Virginia in November, 1902, were established between that date and January 1, 1893—a period of ten years lacking two months.

Some blundering and some unsafe banking have resulted from this sudden multiplication of untrained hands at the business; for the vast majority of these banks are chartered under state law. Yet the agricultural interests have been greatly benefited; and the evils can be remedied by the employment of expert inspectors. The fact that bank failures are rare even in states which maintain absolutely no inspection is conclusive evidence of the long strides forward which the public conscience and the public demands have made in banking.

In Alabama, Georgia, Louisiana, Mississippi and South Carolina the escape of the farmers from the lien system is being hastened and their independence assured just in proportion as they themselves manifest principles of integrity and promptness in their financial affairs; and secondly, as the local bankers or other lenders of cash at legal rates stand ready to make advances to farmers.

Such is the condition of the southern farmer, with whose well being is wrapped up so much of our best interests. He needs better trained and more moral labor, access to credit at reasonable rates when he requires it, and a system of education suited to his life work.

THE NATION'S FARM SURPLUS.

BY GEORGE K. HOLMES.

[George Kirby Holmes, statistician; born, Great Barrington, Mass., May 10, 1856; educated in the public schools; studied law and admitted to Massachusetts bar in 1877; special agent in charge division of farms, houses and mortgages, United States census, of 1890; now statistical expert in charge of domestic crop reporting, United States department of agriculture; Author: Farms and Homes, Real Estate Mortgages; writer on economic and statistical subjects.]

As well try to comprehend the distance of the stars or the duration of eternity as attempt to make intelligible the vast quantities and value of the farm products of this country, or even of the exported surplus, which is so large as to be without parallel among the countries of the earth.

A conservative estimate of the farm value of the farm products of this country not fed to live stock, on the basis of the census valuation, places it at about 4½ billions of dollars. In varying fractions parts of many of these products, not being wanted for national consumption, are conveyed to foreign countries, but are stopped at the ports and international boundaries of this country, where officers of the customs take account of them and make a record of their values and the measure and weight of such of them as are measured and weighed in commercial practice.

The values so ascertained and recorded are not farm values, since to the original farm value of the products have been added numerous charges and profits which the products must bear in the course of a distribution that is often intricate in its business details.

The export value of the exported farm products of this country was $853,643,073 in the fiscal year 1904. During the preceding five years, 1899-1903, the annual average value was $861,037,815, and during the next preceding five years, 1894-1898, it was $616,074,947. During the last eleven years the highest value reached was $951,628,331 in 1901, due chiefly to cotton.

Within these large numbers are included elements of value after the products have left the farmer's hands. The rule of the treasury department is to adopt as the value of these exports their value at the time and place of exportation. Taking a view of exported farm products in general, it is perceived that among the numerous additions to the value of these products after leaving the farm are the profit of the buyer from the farmer at the local shipping place; transportation charges to some trade center or primary market; and wharf charges, as on the great lakes. At the primary market also there may be elevator charges, inspection fees, storage charges, perhaps including refrigeration. Then there is the profit or commission of the dealer at the trade center, which is itself composed of numerous elements of cost, and is by no means all pure profit.

From the trade center the goods may go by rail, canal, or steamboat, or by a combination of these means, to the port, with consequent charges for transportation, while at the seaport there may be storage, perhaps including refrigeration, and the profits or commissions of wholesale dealer and exporter, which profits, as in the case of the first buyer, contain various elements of cost as well as pure profit.

So it appears that by the time the farmer's products have reached the port they are considerably more valuable than when they left his hands; but just how much more so, all products being considered, or even one product, no one has been able to ascertain. While it is possible to follow $4\frac{1}{2}$ bushels of wheat from the farm to the Minneapolis mill and then follow to the port the barrel of flour made therefrom, this is practically impossible for all wheat and all flour. The problem has presented itself to statisticians and is regarded as unsolvable.

Nearly all of the exported products leave this country in steamships, many of which belong to lines having regular sailings, while many are tramps, sailing hither and yon according to the best opportunity of the moment.

Various facts determine through what ports the products shall find exit. Geographical considerations are not always paramount, and, owing to low freight rates or other induce-

ments, railroads may convey more goods to the port of farther distance than to the nearer port on the same coast. The general fact is that the north Atlantic ports have predominated over those which may be regarded as geographically competitive on the south Atlantic and gulf coasts. Within recent years, however, New Orleans and Galveston have drawn an increasing share of the exports of grain and cotton, on account of the immense development of these products in the southwest, and an increase in the southern movement of grain from some of the north central states.

That geographical position may be of secondary importance to a port in the export movement is illustrated by Boston, which exports vastly more corn than Norfolk or Newport News, although considerably farther from the surplus corn states than those ports are. So, in recent years, Boston has exceeded Philadelphia in the export of wheat.

The contest among the principal Atlantic and gulf ports for a large share of the export business in farm products has shifted with varying success; the subject is a complicated one and requires an examination of the rates, facilities, and business of land and water transportation in the United States, terminal facilities at ports, and various accessory influences, each of which would require a long discussion by itself.

As large as the value of our exported farm products is, it is after all mostly composed of the values of a few principal ones. Cotton contributes 36.1 per cent, and grain and grain products 25.2 per cent, so that these two classes of farm products together constitute 61.3 per cent of the exports.

Third in the order of importance is the class of meat and meat products, and to this class may be added live animals; these two classes together constitute 24.3 per cent of the value of exports of farm products.

Hence, it appears that the surplus cotton of this country, the grain and grain products, the meat and meat products, and the live animals equal 85.6 per cent of the exports of farm products.

If to this we add tobacco, oil cake and oil cake meal, fruit and nuts, and vegetable oils, there is no class of exported farm products left with a value as high as $10,000,000. Eight

classes of products, each with an export value of more than \$10,000,000, comprise 95.8 per cent of the farm exports.

Turning from values to quantities, it may be observed how incomprehensible they are. Within recent years, ending with 1903, the cotton exports have been about 3.1 to 3.9 billions of pounds, and the exported fraction of the crop has been between 62 and 72 per cent for a long series of years. In this comparison the export year is compared with the preceding crop year.

With a similar comparison and with the reduction of wheat flour to wheat at the rate of 4½ bushels of wheat to the barrel of flour, it appears that in the last dozen years the fraction of the wheat crop that has been exported has been about 27 to 41 per cent, and the exported wheat and wheat flour, the latter reduced to bushels of wheat, have yearly averaged somewhat more than 200 million bushels since 1897, before which period for many years the quantity was usually 50 to 100 million bushels less.

Only a small portion of the corn or maize crop is exported as corn, the highest percentage, 11.1, being for 1898. In the following year the percentage was 9.2; it was 10.3 per cent in 1900; 8.6 per cent in 1901; only 1.8 per cent in 1902, the year when there was only two thirds of a full crop; and 3 per cent in 1903. Notwithstanding these small percentages the exported bushels rise to 100 or 200 million.

It is in the form of meat, however, that a large portion of the corn crop is exported. In 1903 the beef exports weighed 385,030,329 pounds, the pork exports 551,363,749 pounds, the lard exports 490,755,821 pounds, and the oleo oil exports 126,100,339 pounds.

Unmanufactured tobacco, which may be regarded as the fifth or perhaps sixth export, classed in point of value, was represented in 1903 by an export of 368,184,084 pounds.

Exports of butter and cheese have decidedly declined within two or three years, with several reasons for this result. The exportation of filled cheese and oleomargarine for sale as full cream cheese and pure butter had been carried on to such an extent that the genuine cheese and butter of this country have had a rather bad name in the foreign markets. At the

same time some of our competitors have been careful not only to make high grades of cheese and butter, but to suppress counterfeits, and Canada is conspicuous for its recent achievements in these directions. While this competition in excellence had been to our disadvantage in foreign markets, through its freedom from any taint of deception, a recent competition has sprung up in the large quantities of butter exported from Siberia. Much of this butter goes to Denmark, as in the case of Swedish butter, in order that it may be exported from that country, which has an enviable reputation in the world's markets, and the result is that within a year or so there has been an abundance of butter production in surplus countries, sufficient to depress the price close to the margin of export profit for this country. Another cause of the decline of our butter and cheese exports is the growing consumption in this country, which perhaps has been advancing faster than the production.

Within very recent years exports of butter have been confined to inferior grades. The London prices of superior butter have often been lower than the New York prices; there has been no surplus of this butter for export, and but little of the lower grades.

Among the exports of minor importance in point of value are fruits, yet they attract much attention at home on account of the expansiveness of their markets, and abroad on account of their superior excellence. The exports of fresh apples had grown to 1,656,129 barrels in 1903; of dried apples, to 39,646,297 pounds; of dried apricots, 9,190,081 pounds; of prunes, 66,385,215 pounds; and of raisins, 4,280,028 pounds.

A main reason why the exports of fruits are not greater is the enormous consumption by 80 millions of people at home and a production so far increasing barely fast enough to sustain the increased consumption. Fruit consumption in this country undoubtedly increases much faster than population. Indeed, there seems to be no limit to the market for fruit of first quality.

Within a few years the results of an enormous extension of orchard planting will begin to appear, and some of these results may be found in a much increased surplus for export.

There is room for much improvement in packing in a great portion of the fresh apple exports, most of which go in barrels. There are still too many men who pack the barrels and do not know that they are deceiving themselves more than their customers by putting inferior apples away from the ends of the barrels in the packing. Canada again, as in the case of cheese and butter, has established and secured honesty in fruit packing for export, much to her advantage.

Other relatively minor classes, and yet having large quantities of export, are glucose and grape sugar, with 126,239,981 pounds; cotton seed, 51,622,370 pounds; clover and timothy seed, 33,812,444 pounds.

Notwithstanding the enormous production of eggs, this country has so far been able to export what is comparatively an insignificant number of dozens. The undoubted reason for this, as partly in the case of fruits, is the generous national consumption, which is far outrunning the growth of population.

There is little export of wool; the home production is inadequate to the demands of manufacture, so that vast quantities are imported. A surplus of the hop crop remains for export yearly, notwithstanding the demands of the brewing industry in this country. In 1903 the exported hops weighed 7,794,705 pounds. The starch exports have observable proportions, the quantity in 1903 being 27,759,599 pounds.

The exports of farm products are fundamentally classified as animal matter and vegetable matter, not including forest products. The relative proportions of these two classes of exports during the last dozen years have changed with some irregularity, but on the whole the exports of animal matter are losing ground relatively with a corresponding gain by vegetable matter.

The next inquiry is, Where do our exports of farm products go? It will be remembered that by far the principal portion of these exports was included in the four classes of cotton, grain, and grain products, meat and meat products, and live animals; so in the case of destination of exports there is a concentration, although in a less degree. The United Kingdom takes about one half of the exports of the farm products of this country, and Germany about one sixth,

while France, the Netherlands, Belgium, Canada, and Italy take from 3 to 5 per cent each. Farm products go from this country to many strange and remote nooks and corners of the world. Africa, interior and coastwise, gets them in considerable amounts. Over 2 per cent of these exports in 1902 went to British Africa. Portuguese Africa takes as much as one fourth of 1 per cent of our total farm product exports. China in recent years takes a million dollars' worth of them annually. These exports go to Russian China, to lone islands in the Atlantic and Pacific oceans, to Korea, to the icy shores of Greenland and Iceland, and to all of the many nations of the American continent, of Europe and Asia, and to the various governments of Australasia.

Upon dividing the countries of the earth into six natural geographical sections, it is noticed that the exports of farm products to Europe amount to about 85 to 90 per cent of the total; North America, 6 to 7 per cent; and Asia, South America, Africa, and Oceania less than 3 per cent each.

The principal and conspicuous classes of exports may be traced instructively to their destinations. In recent years about 45 per cent in value of the exported part of the cotton crop has gone to the United kingdom; about 24 per cent to Germany; about 11 per cent to France; 5 to 7 per cent to Italy; from 3 to 4 per cent to Spain; from 1 to 5 per cent to Japan; 1 to 2 per cent to Belgium, Canada, and European Russia. The percentage of the value of exported cotton going to every other country is less than 1 per cent each, and among these countries of less consequence in this matter, yet receiving from this country cotton valued at $1,000,000 to $3,000,000, are Mexico, Austria-Hungary, the Netherlands, and Denmark.

Again, in exported grain and grain products the United kingdom is by far the principal customer, since about one half of these exports go to that country. Germany stands second as a customer, and takes a full 10 per cent of these exports, while the Netherlands stands third and somewhat under 10 per cent; Belgium is fourth in order with 5 to 6 per cent; and Canada fifth with 4 to 5 per cent.

Grain and grain products are much more widely distributed from this country throughout the world than cotton. Wheat being the principal grain exported, the percentages representing its distribution in the principal countries are nearly the same as those given above for all grains and their products.

Of the exported meat and meat products, the United kingdom takes about 62 per cent, Germany about 12 per cent, the Netherlands about 7 per cent, and Belgium 3 to 4 per cent; 1 to 2 per cent of the exports go severally to Cuba, Sweden and Norway, Denmark, Canada, British Africa, France, British West Indies, and Brazil.

The live animal export is mostly to the United kingdom. It consists almost entirely of beef cattle, and that country takes two thirds to 85 per cent of them. For a few recent years British South Africa took most of the exported horses and mules.

Geographical concentration of destination also marks the distribution of tobacco exports. One third of these are to the United kingdom; Germany gets one seventh to one sixth; Italy one eighth to one seventh; France one tenth; and Belgium, the Netherlands, Canada, Japan, Spain, British Australasia, and British Africa from 1 to 6 per cent each.

Oil cake and oil cake meal go principally to the United kingdom, Germany, the Netherlands, Belgium, and Denmark in varying proportions, and the vegetable oils go principally to the Netherlands, France, Germany, United kingdom, and Belgium. The United kingdom gets two thirds of the exported butter and nine tenths of the cheese. The hop market is almost entirely in the United kingdom, and the foreign market is chiefly in Cuba, Canada, United kingdom, and Mexico.

About seven eighths of all exported fresh apples go to the United kingdom, while Germany takes 5 to 10 per cent. Germany gets nearly one half the dried apples; the Netherlands one fifth to one third; Belgium and the United kingdom a tenth each. The prunes are bought mostly by Germany, the Netherlands, United kingdom, Canada, Belgium, and France, and the foreign market for raisins is in Canada to the

extent of two thirds of the export. The remainder goes chiefly to British Australasia and Mexico.

Having observed that by far the principal portion of the value of exports of farm products is concentrated upon a few classes of them, and that about one half of the exports are sent to the United kingdom, and about two thirds to that country and to Germany, it will be instructive to turn to the imports of farm products into those countries for the purpose of ascertaining who the competitors of this country are in those markets, and to point out relative standings.

During the calendar year 1900 the imports of farm products into the United kingdom were valued at $1,577,522,533, an amount not greatly different from the average of recent years. The contribution to these imports from the United States was 32.5 per cent, so that about one half of the exports of the farm products of the United States become about one third of the imports of farm products into the United kingdom.

For the year mentioned France was next in importance to the United States among foreign nations as a contributor to the agricultural imports of the United kingdom, although far below, its percentage being only 6.5; next in order was Germany, 5 per cent; the Netherlands, 4.4 per cent; Argentina and Russia, 4 per cent each; Denmark, 3.9 per cent; Egypt, 3.8 per cent; Belgium, 2.2 per cent; Spain, 1.7 per cent; and Asiatic Turkey, 1 per cent. All other foreign countries contributed less than 1 per cent each.

The British colonies contributed in the aggregate 24.3 per cent, subdivided as follows: Australasia, 9.2 per cent; British East Indies, 8 per cent; Canada, 4.4 per cent; all other British possessions, 2.7 per cent.

The United States has a long lead over its competitors as a purveyor of meat, meat products, and animals to the United kingdom. The cattle imports for 1900 were valued at $43,857,842, of which the United States supplied 72.1 per cent; Canada, 20 per cent; Argentina, 7.4 per cent. The imported fresh beef was valued at $39,724,500, of which 74.2 per cent came from the United States; 14.3 per cent from Australasia; 8.2 per cent from Argentina. The United States

also supplies the principal portion of the imports of salted or pickled beef, cured beef not more specifically indicated, bacon, hams, salted or pickled pork, lard, oleo oil, and cured meats not more definitely described.

As a contributor of dairy products the United States is far behind its competitors. The butter imports of 1900 were valued at $84,922,542, but the United States contributed only 1.4 per cent, thus standing in the rear of Denmark with 46 per cent; France, 10.2 per cent; the Netherlands, 8.1 per cent; Sweden, 5.8 per cent; Russia, 5.6 per cent; and Belgium, 2.1 per cent; and also in the rear of Australasia with 14.4 per cent, and Canada with 3.7 per cent. A better showing is made by the United States in the imports of cheese into the United kingdom, which were valued at $33,276,558 in 1900. Canada contributed 55.6 per cent; United States, 25.5 per cent; the Netherlands, 11.7 per cent; Australasia, 3.2 per cent.

Eggs are imported into the United kingdom in large quantities, their value for 1900 being $26,308,396. These come principally from Russia, Germany, Denmark, France, and Belgium in fractions varying from one eighth to one fifth of the total. Canada sends 5.3 per cent, and the United States only 2.9 per cent.

In the great totals of imports of cereals into the United kingdom the United States stands pre-eminently conspicuous, as in the case of meat and meat products. That country received from abroad wheat to the value of $113,612,963 in 1900, and about one half of this came from the United States, one quarter from Argentina, 9.5 per cent from Canada, 6.5 per cent from Russia, and 5.6 per cent from Australasia. The imported wheat flour was valued at about two fifths of the wheat imports, and more than four fifths of this flour came from the United States, while Austria-Hungary supplied 6.2 per cent; Canada, 5.7 per cent; France, 3.2 per cent; and less than 1 per cent came from Argentina and Russia together.

Naturally also the chief portion of the imports of maize is from the United States, the fraction being 69.7 per cent of $59,993,526. Argentina sent 12.3 per cent; Canada, 8.7 per cent; Roumania, 4.9 per cent; Russia, 3.9 per cent.

In barley imports the United States, Russia, and Asiatic Turkey each supply about one quarter, and about one third of the rye imports are contributed by Russia and nearly the same fraction by the United States. In oats, however, Russia is far in the lead, with more than one half of the contribution to total imports valued at $25,482,984, while the United States sends a little over one quarter, and Germany less than one tenth. Nearly all of the imported maize meal and oatmeal and groats come from the United States.

The greatest of all the United kingdom agricultural imports is raw cotton, the value of which in 1900 was $199,441,794. The cotton supplies of the United States found practically no competitor in the same grades of cotton in the British market, the supply from this source being 73.7 per cent of the total. The Egyptian supply was 22.1 per cent; that from the British East Indies, 1.7 per cent; and from Brazil, 1.6 per cent.

This country has a strong hold upon the British market in the supply of some fruits and a weak one in others. Nearly one half of the imported fresh apples came from this country in 1900; one third from Canada; one tenth from Australasia. The imported fresh apricots and peaches are of small value, and the United States supplies only one tenth; most of the imports come from France. Fresh pears are more important, and were valued at $1,785,324 in 1900, of which over one tenth came from this country; France supplied about two thirds, and Belgium nearly one fifth. More than one half of the imported prunes came from France and about one third from the United States.

A considerable quantity of hay comes from the United States to Great Britain, the value being somewhat less than $1,000,000 in 1900, or 42.5 per cent of the total imports; one quarter of the imports were from the Netherlands, one eighth from Canada, and over one tenth from France.

The principal portion of the hop imports comes from the United States—73.6 per cent in 1900, Belgium being in second place, with 17 per cent. Nearly three fourths of the cotton seed oil cake is derived from the United States, and the principal competitor is Egypt, with nearly one fifth; but in the

case of flaxseed oil cake the United States contributes only one quarter, while Russia and Germany supply about one third each. A large amount of cotton seed is imported which comes almost entirely from Egypt. The imported flaxseed is mostly obtained in the British East Indies, Russia, and Argentina.

The tobacco supply of the United kingdom was valued at $14,281,031 in 1900, and 84.4 per cent of this was obtained in the United States; 9.2 per cent from the Dutch East Indies.

Germany has hardly one third of the importance of the United kingdom as a recipient of exports of farm products from this country, yet the total imports of farm products into that country in the calendar year 1901 were valued at $790,564,700. The United States contributed $172,837,600, or 21.9 per cent, this fraction being larger than that of any other country. Russia stands second, with 16.3 per cent; Austria-Hungary third, with 10.6 per cent; then follow the British East Indies, with 5.6 per cent; Argentina, 5.4 per cent; Italy and France, 4.4 per cent each; the Netherlands, 4 per cent.

Farm products constitute a much larger percentage of the imports of the German empire than they do in this country, the percentage for Germany being 59.2 for the five years 1897–1901. Of imports of agricultural raw materials, the United States supplied 20.5 per cent in 1901; food products, 21.7 per cent; feed stuffs, 37.3 per cent; miscellaneous farm products, 3 per cent.

With a more specific classification of imported farm products the position of the United States as a contributor may be better understood. This country sent to Germany 57 per cent of the value of its imports of meat products in 1901; 55.7 per cent of the vegetable fibers (almost entirely cotton); 35.3 per cent of the grain and grain products; 8.2 per cent of the tobacco; 6.1 per cent of the fruit and nuts; 5.7 per cent of the seeds; 2.3 per cent of the hides and skins; one fourth of 1 per cent of the live animals; and only one tenth of 1 per cent of the animal fibers.

Such small quantities of butter and cheese find their way from the United States to the German markets that the former country can hardly be looked upon as having any footing in German markets in the sale of these products. Only three

quarters of 1 per cent of the total imports of dairy products come from the United States. Very little fresh meat of any kind comes from this country, but the United States supplied 85 per cent of the cured beef in 1901; 85.1 per cent of the bacon; 46.2 per cent of the hams; 59.5 per cent of the salted or pickled pork; 97.6 per cent of the lard; 98.2 per cent of the lard compounds; 93.8 per cent of the oleo oil; 26.2 per cent of the sausage casings; 63.8 per cent of the stearin; and 47.7 per cent of the tallow. The principal competitors of this country in these classes of German imports are Denmark, the Netherlands, Austria-Hungary, and, in sausage casings, Russia; in tallow, the United kingdom and British Australasia.

In 1901 the apple imports of Germany were nearly one half derived from Austria-Hungary; about one fifth from France; one eighth from Italy; one eighth from Belgium; and only 2.4 per cent from the United States. Almost no other fresh fruits were received from the United States; but a large quantity of dried fruits (not elsewhere specified), including dried apples and prunes, was received from the United States, their value being $2,078,100, or 43.4 per cent of the total imports of this class. The chief competitors were Austria-Hungary and Servia, each contributing one fifth, and France, one tenth.

Germany's imports of wheat in 1901 were valued at $67,283,100, of which 58.4 per cent came from the United States; a little over one fifth from Russia; one tenth from Argentina—but the United States was exceeded in the supply of wheat flour by Austria-Hungary, which contributed 58.8 per cent as against 28.7 per cent by the United States. About one half of the barley imported into Germany comes from Russia, and two fifths from Austria-Hungary. The United States makes a bare showing. One fourth of the imported buckwheat is from the United States and more than one half from Russia.

As might be expected, the United States contributes the principal portion of the supply of imported maize (about two thirds); Argentina sends about one eighth, Roumania about one tenth, and Russia about one twentieth. Russia sends about seven eighths of the oats and the United States about

one tenth; Russia about nine tenths of the rye and the United States one twentieth.

Almost the entire imported malt comes from Austria-Hungary; the bran is supplied by Russia, Austria-Hungary, Argentina, and the Netherlands, in order of importance, with the United States contributing only 3.2 per cent

The oil cake and oil cake meal received from the United States by Germany in 1901 were two fifths of the total imported; from Russia, one fourth; from France, one twelfth. The imported flaxseed comes mostly from Argentina, the British East Indies, and Russia, leaving only one tenth of the imports to the United States. Two thirds of the imported leaf tobacco comes directly or indirectly from the Dutch East Indies, about one eighth from Brazil, and one twelfth from the United States.

From totals of incomprehensible magnitude and from a bewildering mass of details concerning the exports of farm products from this country, classification and comparison reduce the subject to what are, after all, rather simple terms when separated from numerical aggregates.

The vast total of exports is composed mostly of cotton, grain and grain products, and meat and meat products, with places of much less although of large importance taken by tobacco, live animals, oil cake and oil cake meal, fruits and nuts, and vegetable oils. With attention concentrated upon three or four, or at most upon all these eight classes of products as exports to the countries of the earth, it may be still further concentrated upon the United kingdom as receiving one half of all this country's exports of farm products, and, in a less degree, upon Germany, the recipient of one sixth, all other countries being individually of minor importance in the general survey.

So it becomes easy to find our principal competitors, which are, in meats and meat products, Australasia, Argentina, and Canada, and Denmark in bacon; in live animals, Argentina and Canada; in grain and grain products, Argentina, Russia, Canada, and Roumania, and at times British India and Australasia; in tobacco, the Dutch East Indies; while in cotton the other countries of the earth have not yet produced a direct competitor of the upland varieties grown in this country.

HOW THE DEPARTMENT OF AGRICULTURE AIDS THE FARMER.

BY JAMES WILSON.

[James Wilson, secretary of agriculture; born, Ayrshire, Scotland, August 16, 1835; came to United States in 1852 and settled in Connecticut; went to Iowa in 1855; engaged in farming, 1861; member of the twelfth, thirteenth and fourteenth assemblies of Iowa; member of congress, 1873–7 and 1883–5; regent, state university of Iowa, 1870–4; director, agricultural experimental station, and professor of agriculture, Iowa Agricultural college, for six years; appointed secretary of agriculture, March 5, 1897.]

Some years ago the people who handled tobacco wanted the department to tell them something about tobacco growing in certain localities and how to produce certain kinds. The question became an interesting one. I began to look into it. We sell nearly $30,000,000 worth of tobacco every year, most of it very cheap and poor, and we buy $14,000,000 worth of the finest tobacco in the world. Some of our people are able to make very valuable cigars. I remember hearing of a Cuban down in Florida who was supposed to know something of the A B C of tobacco. I went to Florida to find out all about the matter and I found that the people there who were supposed to know all about this subject did not know anything but what their fathers had known, and their fathers did not know anything but what their grandfathers had told them.

Then I called on the scientists of our department and said: "Gentlemen, have any of you an answer to the question why one cigar sells for 2 cents and another for 50 cents?" The answer was "No." I said: "The dairymen have determined what it is that flavors butter and what it is that ripens the cheese. Now what is it that flavors tobacco, do you suppose?" The answer was, "We do not know; we have not gone into that question." I said: "Let us go into it." So our people went into it. They found that the bacteria that flavor butter do not flavor cigars; that in tobacco there is no such thing as bacteria; bacteria can not live there. We made

further inquiry. We wanted a man who could take the leaf of the tobacco plant, analyze it, and tell us what it contained. We got a German scientist who had just come to this country. Dr. Babcock, of Wisconsin, had discovered that the principle which ripens cheese is a ferment found in the milk; this man discovered that the principle which is instrumental in curing tobacco is a ferment. About that time along came the Japanese government and offered this man $7,000 a year and took him to Japan.

Then I called on the great universities of the country. We are a great educational people; about half the taxes goes for education. I wanted a chemist to come and analyze the tobacco leaf and tell me what it contains. I could not find one. There has not been any education of that kind carried on for the benefit of the farmers. We took some doctors of chemistry, and put them under our plant physiologists and pathologists, so that they might learn something about the chemistry of a tobacco leaf. And we are still waiting; we are just holding right on. We have shown the people of the Connecticut valley how to grow $6,000,000 worth of wrapper tobacco that we formerly got from the Dutch who live in Sumatra; but we have not been able to show anybody how to grow $8,000,000 worth of fine tobacco such as we get mostly from Cuba. We are at work along those lines. We had our physicists try to find out what was wanted. We could find soil similar to the fine Cuban soil where the tobacco grows. I wanted a soil physicist. I hunted all over America.

We found it necessary to educate our own people along those lines. We have found a place in Pennsylvania where the soil looks like the fine soil of Cuba, and we are trying whether we can grow fine tobacco there so as to save Uncle Sam $8,000,000 that he is now paying out for that fine Cuban tobacco. We found another place in Ohio, another in Texas, another in North Carolina, with a fine soil that we suppose might raise this fine tobacco. We are trying the experiment there. We are going to work away to try to educate somebody that can analyze the juices of the tobacco leaf, so that finally we may save Uncle Sam a great amount of money that he is now spending abroad for foreign tobacco. Cigars from

the Texas experiment station in a great many regards are as fine as the Cuban cigar, but they are a little too strong. We must try whether we can not get a milder cigar.

We have the old fashioned old country education over here. We have borrowed the most of it. It was invented and organized long ago. The object of a college in old times was to train preachers. Now they have enlarged the scope of the college, and they educate men for what we understand to-day as the professions, such as the lawyer, the doctor, the dentist, etc. Men spend immense sums of money for education along those lines. We have more professionals than we have jobs for; and the fellow who acts as brakeman on a railroad gets more money on the average than the professional that has been educated in some of those fine colleges.

It is necessary in our department to educate men to do the work; otherwise it can not be done. A large number of young men and women are now being trained in the department of agriculture simply because the colleges and the universities are not giving the kind of education that we require.

Congress has been induced to grant land to establish agricultural colleges. Each state received 40,000 acres of land or the equivalent, and from the proceeds of that land grant colleges have been established. We assumed that if we only got the colleges established, teachers would be educated for agriculture all along the line. We know now how few teachers this country has. Some of those colleges have done grand work, as they happened to have grand men and women in them. Some of them had boards of trustees or faculties who had no hesitation at all in taking the money given by congress for the education of the farmer and applying it to the education of anybody else who wanted to be educated in any other direction.

Now, you can not educate a man in all the sciences that relate to agriculture if you wait until he has gone through the primary school and the secondary school and the grammar school. The college that is to educate a man must educate him in the sciences relating to agriculture all along the line. What a pretense to undertake to educate him in all these things after he has graduated in some college! It never has

been done. You must begin with the child and educate him for his future life work. As a general proposition, the young man will not go to college unless you put on the shelf some goods that he wants to buy. Should a young farmer go to college and study Greek? For what purpose? Do you see anybody, after he has been through a college or a university, using Greek or Latin anywhere? Those classical lines of education have my admiration as training for the men for whom they are designed. I do not oppose any kind of education. But that kind of education is of little use to the farmer.

There is a pernicious idea abroad in the land that you must first give a man a general education, an education which shall be broad, an education which shall include the classical languages and mathematics and philosophy; and after you have graduated him from a college at which he has studied all these things, you have then, as is supposed, a foundation upon which you can establish a superstructure in any direction you want.

The farmer's boy who intends to be a farmer, and his father who intends to have the son succeed him on the farm, do not care anything about that kind of education. My idea of education is that it should fit a young man for his future life. If he is to be a physician, let him be fitted for that; if a minister of the gospel, let him be fitted for that, and if he is to be a farmer, let him be fitted for that.

The farmer's education must begin when he is but a child, and the question is how? In a Missouri commencement I found that they have taken there what I believe to be the right course. They send for the school teachers in the summer time and instruct them in the summer school how to teach agriculture in the primary schools. The state of Alabama gives $2,500 a year for an agricultural school in each congressional district in the state.

I would not educate those school teachers at their own expense; I would educate them at the expense of the state, my object being that, beginning with the child, they should instruct him in the rudiments of agriculture, in the elements of the science of agriculture. The children should be edu-

cated to know the difference between a grass and a legume. You can teach those young people by means of plants planted in the school grounds if necessary. You can have each one bring you a plant, and when it is brought you can tell him about it. If a field has been harrowed, let them run over it; and the next morning they will see where the moisture has collected in the footprints they have made on the ground. And then you can tell them why. You can lead them step by step from such beginnings to the use of the roller and the harrow. I would begin with those young people along that line; I would continue this kind of education through the secondary school; I would prepare them for the agricultural college, and they would go there as naturally as a boy goes to the pantry to get some bread and butter with sugar on it. But just now our system of education draws the young people away from the agricultural college into something else. And the mothers probably have to work pretty hard on the farms, and they really do not want to see their boys become farmers. The mother would rather see her son wear a black coat like the lawyer and the teacher and the dentist. I do not think the mother encourages the boys very much to become farmers, and I do not know that the family preacher encourages them much, because he was not educated that way; and I do not think the family doctor gives them much encouragement for the same reason.

Our common school system is the finest the world ever saw; but there are millions of dollars expended just now in technological schools. Germany has 145 chambers of commerce, and 112 of those are paying money regularly to educate young men in commerce. That is how to make great commercial men. The American people are extending education in similar directions. One day while away off on the Pacific coast I was waiting for a train. Somebody said: "Won't you step into the car and see how the railroad men are educated?" There was a man going from place to place with a car instructing the railroad men in everything pertaining to their business. So, too, are manufacturers taking hold of the work of technological training. Everybody is being educated in his peculiar branch except the farmer; and why should not he

be? What progress are we making along those lines? Can we take encouragement from what is being done? I think so. The demand is very great. The province of Victoria in Australia sent a man to the United States last summer and offered two chiefs of bureaus in the department of agriculture $10,000 each to go out there to organize agriculture in that province, but neither of them would go. Just now I have three places in my mind for which we want men to take charge of branches of work in the agricultural colleges, and I do not know where to put my finger on the right men. It is a big responsibility to send a young man off to one of the states to organize this work, and it is difficult to get men for the work, because they are offered bigger pay from other sources. You can get a man who is well up in animal husbandry or agrostology, or any of those sciences that a young man must learn to be an intelligent farmer, for the same pay for which you could get a man to teach anything else. You can telegraph to a large city and immediately get by the carload young men educated the old way, but you may send all over the country to get one man to carry on agricultural instruction with regard to animal husbandry or with regard to the different qualities of soil and you can not find one. Education along these lines has begun lately. One thing that should be encouraged is the work that is being done by congress. Congress endowed the American agricultural colleges. It has gone further and given $25,000 a year to each of them. Then it gave each of them $15,000 a year to establish an experiment station. The department of agriculture is getting over $5,000,000 a year now to help the farmer all along the line.

The question is coming upon us, now that we are opening the Orient, whether the Chinaman may not produce things so much cheaper than we can produce them that we had better never have opened it up at all; better have kept away from China. One of our American citizens, coming back from China, told of his visit to Canton. He told us that he spoke there to an intelligent body of Chinamen through an interpreter. He stated the amount of work that a man could do in a Chinese rice field in a day. That they understood, because they saw it done every day. Then he told them of the

amount of work that one man with machinery did along the gulf coast of the United States, and that they could not comprehend. He told them that one American, with the aid of machinery and other modern appliances, can do as much in the rice fields in a day as 400 Chinamen. That they could not comprehend. These are the lines along which we want to educate. We want to give more power to the American farmer all along the line.

There has been a long tussle in congress about beet sugar. Our farmers need to be taught how to cultivate the beet; they do not yet know how. If our sugar beet growers should grow only the third of a possible crop, it would not make a bit of difference to them what congress did.

The fifty eighth congress dealt with two great subjects. One is the irrigation bill; another is the Appalachian forest reserve bill. Both have reference to utilizing the rainfall; both have reference to securing moisture for the soil. I believe firmly that the atmosphere takes up just the same amount of moisture from lakes and river and ocean that it ever did. "God hath made man upright, but they have sought out many inventions." We have been here between the rainfall and the river. We have been changing the face of the continent. We have been cutting down the forests, and doing it as fast as we could. The timber that we have in the northwest is being cut into lumber by 700 sawmills just as fast as it can be, some of them at the rate of 100,000 feet a day. Our people west of the hundredth meridian are complaining that they have not enough moisture to grow crops. The people in the states of Illinois and Iowa have 35 inches of rainfall, and they are wonderfully blessed. The people on the gulf coast have a rainfall running from 50 to 60 inches, and the people of the north think that they are wonderfully blessed. But there is just as much complaint from the man that grows cotton in the south as from the man who grows wheat along or near the one hundredth meridian. Why is all this? Our good friends in the south have been cultivating and cultivating and cultivating. They have been burning up the humus from the southern soil; they have kept at it for over a hundred years until there is not much left. It will not

stand drought any longer because there is not organic matter in the soil to retain the moisture.

At the hundredth meridian is a deep, rich, brown soil which, with proper moisture, can grow anything. But whenever there comes a dry year it means calamity. What is the matter in the south? Is it the soil or the people? What is the matter at the one hundredth meridian? Is it the soil or the people? The soil of the south has been washed into her great rivers. Half the water in their rivers is mud; thus they are carrying away the soil, because the farmers are not educated to conserve that moisture.

At the one hundredth meridian there are not any rivers to carry away anything; consequently plant food stays there. If you can get the necessary water upon the soil, you can grow most enormous crops. I have seen 80 bushels of wheat to an acre; I have seen a thousand bushels of potatoes to an acre, growing there. They have never lost a particle of their plant food from their soil. There is no water to carry it away.

There are two problems—one down on the gulf coast, another up at the one hundredth meridian, this side of the Rocky mountains. Each has a problem. The department of agriculture is hunting the world over to find plants to suit the south and to find plants to suit the great northwest. We have been paying $8,000,000 a year for macaroni to the Italians, and it is not over nice to look at or think about. Macaroni wheat will not make good bread, and bread wheat will not make macaroni. We have sent our explorers all over the European and Asiatic world, and among other things they have brought us macaroni wheat, and we have it growing all the way from North Dakota to Texas. They grew some 200,000 bushels of it in 1904. Some people in Cleveland, Ohio, built a mill to make macaroni; and the excellent macaroni they did make! But the farmers, who had planted 185,000 bushels of the wheat, would not sell it to the millers. And the millers undertook to bring pressure upon me through their congressmen to have me get more macaroni wheat seed. I told them if they would only wait until thrashing time they would get all they wanted. The result of our raising our own macaroni wheat is that we shall save $8,000,000 that we have

heretofore sent abroad for the purchase of macaroni; and we shall eat the macaroni with much better relish; at least I shall.

These are the lines along which education is needed, and I think that Missouri is on the right track. Begin with the child; start the child in the rudiments that relate to agriculture and carry him on up to the agricultural college. Already in regard to education our farmers are taking the lead of farmers everywhere in the world, because the average American, going through our average schools and reading our American books and newspapers, is really the best informed average man that the world has to-day. In this matter we are going ahead remarkably fast. The government is helping the people along these lines. We have people all over the world finding out things that we want to know. We sent one of our agricultural explorers across Tripoli and across part of the Sahara desert some years ago, and he got some big date palms. We had them transported to Arizona. Then we wanted an earlier variety of the date palm. So our explorer goes up along the shore of the Persian gulf to where there is an earlier variety.

In 1900 we were producing only 25 per cent of the rice that we consumed in the United States. The cry came up from the people along the gulf coast, "Our rice is a long, thin, carbonaceous sort of rice which does not turn out as we would like in thrashing; can you find us a better species of rice somewhere?" We sent one of their people off to Japan; and he found a flinty rice, shaped a good deal like wheat, and one that doesn't break up in thrashing. We brought over ten tons and started it all over the gulf coast; and the next year we raised 100 tons of it in this country. The crop that is growing will supply all the home demand for rice; so that we shall not have to buy rice from abroad any more; on the contrary, we shall begin to export rice. The people in Porto Rico are now buying our broken rice that we used to sell to the breweries. It just exactly suits them. It is a godsend to them. They have not been getting quite enough rice of any kind.

The people on the sea islands off Charleston sent up word to us that the cotton was dying. They grow a fine long cotton there. We sent a pathologist down there and told him to find out what was the matter. He came back and told that there

was a fungus that attacked the roots of the cotton away down below the surface of the earth. He did not know what to do about it. A consultation of scientists was had, and he was sent back with these instructions: "If you find in that field one plant that did not die, save the seed of that. Then take some of all the varieties of cotton that grow in the United States and plant them there. Some may be immune. Crossbreed all these varieties. You may get a variety that may be immune. Stay there quietly pursuing your investigations for four years." While this line of investigation was going on we discovered that they have in Michigan a certain form of peach disease. The peach falls off when it is half grown. The people did not know what was the matter. Our department men last fall got a hint from the fungus which had been found at the root of the cotton plant. They found a similar fungus at the root of the Michigan peach. Now, we propose to import some specimens of the peach from its original home in Asia. The peach there has stayed healthy all along the centuries. We are going to try to meet the difficulty in Michigan by introducing that Asiatic peach.

One of our latest developments is the raising of green tea in South Carolina. It is only a question of time when we shall be raising our own tea. Green tea is usually artificially colored by the use of either prussian blue or copperas. Our people have been studying how to retain the greenness of the leaf without using any of these poisonous chemicals. Taking a hint from our investigations in regard to tobacco, we have found that the tea leaf has a ferment within it, and when you pull the leaf it associates itself with the oxygen of the atmosphere, and there you have green tea. Then they subject the green leaf to heat up to a high temperature to kill that ferment, so that it can not associate itself with the oxygen. Then they did not know how to get that gray shade which is on green tea. They obtained the services of a Chinaman, to whom they gave big pay. He did the work all right, but he did not let them see how it was done, and he would not tell them. But they discovered that the effect was produced by abrasion, and now they are making a pretty green tea. Hence, it is only a question of time when we shall grow in this country

our own tea. We are now making tea which is finer than any that can be imported. There are imported teas that sell for as much as $1 an ounce.

The question naturally suggests itself, are you going to succeed in raising American tea without a protective tariff? I answer, yes. I do not want to bother congress about a tariff on tea. American ingenuity will find some means of making one man do the work that it requires two or three hundred of those Orientals to do. I do not undertake to discuss the social problems of the south; but I know that the little colored boys and girls down there can be much better employed picking tea than running idle. By American ingenuity we shall in some way solve the problem of competing with the cheap labor of the Orient. The American will improve anything he looks at; he does not look at a thing twice without suggesting an improvement.

Some day we shall be growing our own raw silk. Congress might well appropriate some money for assisting in this work. Besides the manufactured or finished silk that we import, we are now paying $50,000,000 a year for the raw silk. I have arranged to have millions of mulberry trees sent all over the south. In a couple of years those trees will be ready to yield their leaves, and then I shall have the colored women taught to do the rolling.

PROBLEMS OF THE AMERICAN BOTANIST.

BY B. T. GALLOWAY.

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To one who is necessarily thrown in contact with the somewhat hurly burly affairs of life, the old meaning of botanical work is gradually giving way to something else—something that reaches out into practical affairs and pushes its way into paths where, a few years ago, the botanist would have feared to tread.

Now the question arises, is botanical science to suffer by this movement or is it, after the first preliminary efforts, to emerge rehabilitated, stronger and more vital than ever before? I have neither fear nor doubt as to the outcome, and believe that the spirit that has made us commercially a leader of nations will enable us to build up a science which neither time nor change can seriously affect. It hardly needs any extended statement to call to mind the rapid changes which have taken place in botanical work during the last twenty years, yet a critical study of these changes is, to me, one of the most hopeful signs that our progress has constantly been in the direction of a stronger place in the world's usefulness and a higher plane of scientific thought. Twenty years ago the botany taught in our universities and colleges was of such a nature as to meet the general requirements of the time. It broadened out rapidly during the last ten years of this period, but it was still limited in large part to systematic studies, with some few attempts here and there to enter the field of morphology, physiology and the kindred branches. Perhaps no one thing has given a greater stimulus to applied botany than the organization of the various state experiment stations, under what is known as the Hatch act, which be-

came a law in 1886 and went into active operation a year later. Under the broad authority thus given in this act, establishing a station in each state and territory, opportunities were afforded for advanced studies of both plants and animals in their bearing on agricultural development, and as a result there was an extraordinary demand for men, which, even yet, it is impossible to meet.

Coincident with the establishment of the experiment stations came a broadening of the work of the national department of agriculture, thus creating the need for still more men trained in certain lines. At this time the era of specialization was scarcely upon us, but such was the demand for men and work that the stimulus to those engaged in special lines was great.

This country was not alone in the movement which has just been described, for in Europe, and particularly in France, there was experienced the same need for help in applied lines, and as a result extraordinary efforts were put forth by those in charge of chairs in the various institutions of learning to meet these demands. The happenings such as we are describing are met with frequently in the progress of the world, and really are the culmination of more or less subjective thought, which, when the proper moment arrives, breaks into force and makes itself felt in an objective way. It is found, therefore, that while this work was making rapid strides, the demand was so great for immediate practical results that sufficient attention was not always given to that accuracy and precision of conclusion that the world's best thought demands. There was a proneness, in other words, to sacrifice accuracy to utility. Helmholtz, long ago, sounded a warning on this subject when he said that "Whoever in the pursuit of science seeks after immediate practical utility may generally rest assured that he will seek in vain." On the other hand, there is a class of investigators, and their numbers are considerable, whose work, for the most part, is largely ahead of the practical side. Possibly, taking all of the work that has been done in the country, the need is not so much for more research, but for the practical application of the researches already made to the everyday affairs of life. In

some branches this, of course, has not been the case, as is evidenced by what has been accomplished in a number of important fields during the past fifteen years.

Of the different branches of botanical science that have been applied to the betterment of man, physiology and pathology stand pre-eminently to the front. We cannot lay any great claim to much in the way of studies in the pure science of physiology, but the practical application of these studies to the affairs of life has been considerable.

In passing I may be pardoned for emphasizing somewhat in detail a fact that seems to be little appreciated, and that is the great value and usefulness of the individual or organization that can bring to the attention of the people the results of scientific work in such a way that mankind as a whole is bettered, and the struggle for life is made less a burden. What value to the world is a scientific discovery unless it is clothed by some genius with a force that will bring its usefulness home to thousands, where before it would have been known but to a few of the elect? While willing to admit that America, for very good reason, has not as yet been able to take front rank in the way of original discoveries, no one will deny the fact that our country has quickly turned to practical account discoveries of all kinds where there was a promise of practical results. So that while in physiology, laboratory investigations have been pushed with vigor abroad, our efforts have been in the past mainly in the direction of broad field work, which has added materially to the wealth and power of the country. This is particularly the case with the work on legumes and the application of laboratory studies to the problems connected with nitrogen supply and the rotation of crops. The extended work of Laws and Gilbert and other experimenters has done much to emphasize the value of the broad application of laboratory research in this field. It sometimes happens in work of this kind that its application is of such a special nature as to preclude a proper appreciation of its value in a general way. Such, for example, is the work of Löew, who three years ago undertook a very special problem having to do with the handling of tobacco, and which, in two years, was practically finished, but so changed the

aspect of the work that it opened great possibilities in building up an important industry and adding wealth to the country as well. The keen competition in tobacco growing, and the fact that the finest grades were, in a large part, imported, made it very desirable and important that all available information in regard to the crop be secured. The chief problem upon which light was needed had to do with the fermentation of the leaf. Prior to Löew's work it was generally held that fermentation was, in large part, due to bacteria, and that the difference in the aromas of tobacco might, to a certain degree, be controlled through the action of these organisms. Löew's work showed that the fermentation of tobacco was due to enzymes. The enzymes causing the fermentation were isolated, and methods for controlling them were pointed out. As a result of this work improved methods for handling the crop have been developed and new industries established. Such, for example, is the Sumatra tobacco industry developed in Connecticut, which owes its incentive to the advanced work of Löew, and which bids fair to add a great deal to the material wealth of the country.

Plant breeding is another branch of applied work closely related to physiology, which has made rapid advances during the past few years. It is true that plant breeding leads off into horticultural and other fields, but the advances that have been made in this field in recent years have had their inception largely in botanical studies. The work, as a whole, has had for its object the advancement of industrial pursuits, and has aided materially in adding to the wealth and progress of the country. It is true that in some cases applied work in this line has been pushed in advance of scientific research, but this has led to no serious results, for notwithstanding a lack of knowledge as to the full scientific significance of the various operations performed, the results have in most cases shown far reaching intuitive knowledge on the part of those who have actually been engaged upon the various problems. What has been accomplished by Bailey, Webber, Waugh, Burbank, Hays, and others has shown great possibilities, and the improvements made in many crops will, no doubt, in time, prove of more value than even the present seems to indicate.

In no branch of botanical science have the advances in applied work been more pronounced than in pathology. Twenty years ago plant pathology was practically unknown in this country. Little or no attempt had been made toward systematic work in this field, and what had been accomplished was largely in the direction of applying information secured as a result of investigations abroad. The first attempts in the study of pathological problems were naturally confined to questions having to do with parasites. The effects of parasitic enemies of plants were pronounced, and gave opportunity for the most ready investigation. In looking back, therefore, on the early development of the work, it is not strange to find that investigations for the most part were in the direction of economic mycology, for it was largely a study of parasitic fungi in their relation to plant diseases. The important problems connected with the relation of the fungus to the host and host to fungus were, for the most part, overlooked. Pathology, therefore, had its inception largely in mycological investigations, which later developed into a study of the host itself. This naturally led into the field of plant physiology, and developed slowly the important work of investigating plant environment and its relation to pathological phenomena. It was early seen that no sharp lines of distinction could be drawn between any of these various branches, and for that reason it became important to push the investigations along several different lines. To the early workers in this field is due the credit of laying the foundation which paved the way for a full understanding of the broad problems elucidated later, and as a result the science itself has been established on a firm basis.

It is practical application of this science, however, that has attracted such widespread attention everywhere, especially the work that has been done in this country and in France. Prior to 1885, very little was known in regard to the treatment of plant diseases. The discovery of the efficacy of certain compounds in the treatment of crop diseases about this time led to a rapid awakening of the importance of the subject, and for the next few years there was a phenomenal advancement in the field treatment of plant maladies. Improve-

ments in laboratory methods also did much to stimulate advanced work, and made possible lines of research which were not practicable before the discovery of such methods. What has been accomplished in this field alone has done much to encourage applied work and to show the importance of such work as an aid to the advancement of pure science.

It has become the practice of late to ignore the important part that systematic botany has played in making known the practical value of plants to the human race. In the rage for special problems, the fact is often overlooked that many of them owe their inception to prior efforts in taxonomic lines. It is hardly necessary or essential to go into details upon the bearing of systematic botany to applied work, but in passing, attention should be called to the great benefit that has come to the country as a whole through the important work on grasses, forestry and medicine. Some of the earliest work on economic lines in this country was based primarily on the systematic study of grasses, the object being to determine their agricultural value. The early investigations of Vasey did much to call attention to the value of applied botany, and there has been developed from this work very important and far reaching lines of research, such as are now being carried on by the United States department of agriculture and many of the experiment stations. This work, while having for its basis systematic studies, extends into broad fields of agronomy and other lines, such as have to do with the improvement of pastures, or range lands, and many other similar lines. The same is true of many of the important investigations that have been carried on in the matter of studying of noxious plants, as, for example, weeds, etc.

The advance forestry work of the present also owes its inception, primarily, to systematic studies which were begun years ago, and which are still continued, in order to form an intelligent and rational basis for many of the advanced problems in this field.

In medicine too, the study of systematic botany has played an important part. It was the general practice in the early days for physicians to be trained in botanical lines, and a great deal of our important information has been brought

by these same physicians. In fact, it has generally been considered necessary for physicians to be pretty well posted on botanical matters; hence the close relationship of botany to the practice of medicine has always been recognized. With systematic botany as a basis the study of materia medica has advanced rapidly and has formed an important item in the development of our work. The differentiation of pharmacy from medicine has also led to further advancement in these lines, and has done much to advance the value of the investigations.

Probably in no other field of botanical science has the applied work been of more value to mankind than in bacteriology, surgery and sanitation. The systematic study of the causes of diseases has led to most valuable results, and in nearly all of these investigations the inception of the work can be traced to one or more lines of botanical science. Such, in brief, have been some of the advances in applied botany in this country, and with this somewhat hasty sketch in mind, let us turn our attention to the future and consider what opportunities are before us and along what lines our efforts should be put forth in order to achieve the highest and best results.

Attention has already been called to the importance and necessity of constantly keeping in mind the fact that in the application of science we cannot be too careful as to the foundation of our work. In the race for results we are apt to lose sight of this fact, and in the end we find, too late, that our entire fabric has been built of straw and tumbles to earth at the first gust of wind. It is necessary, therefore, in looking to the future development of applied work in this country, that we turn our attention, not so much to the older men who are already in the field, but to the younger generation who are still to come up, and the training they are getting, or are apt to get in the various institutions of learning throughout the country. It is too true that many of our institutions of learning have been slow to recognize applied science; and even now, with all the demand for applied work, little or no effort is being made to put this work on the basis where it belongs. The training in applied lines at this time is meeting

with much the same opposition that science itself did when first introduced into our colleges—especially science as taught by laboratory methods, rather than science as taught by handing down from year to year knowledge long stored in dusty tomes. There was a time, and not so far distant, either, when to be a student in a science course in some of our institutions required considerable moral stamina; but all this is changed with respect to science, yet there still lingers that inherent hostility to all things practical, as is most strikingly emphasized in institutions where applied work, such as agriculture, engineering, etc., is made a part of the regular course. With the great increase of wealth in this country and the commendable spirit being manifested in the endowment and establishment of institutions of learning, the fact must not be lost sight of that there may be some danger, as has been pointed out, in building up an educated proletariat, a class who, as specialists, will care more for getting their names attached to abstruse technical brochures than they will for a treatise that will enable some struggling mortal to make life less a burden. Some one has truly said that the danger from education is not so much from its quantity as from its character, so that it is the character of our training that should receive most careful, conscientious, and considerate thought.

This leads us now to a consideration of the nature of the training our young men should receive in order to fit them more especially for the opening fields of labor in applied botany, and at the same time make good citizens of them, whether they go into the work in question or some other equally important. Pure science, of course, must form the groundwork for this training, but in addition to that there should parallel with it, throughout the entire course, a rigid system of training in the application of science to the practical affairs of life. It is needless to say that we do not have, anywhere in this country, at the present time, such a course of training in botany; and for this reason the men who go into this kind of work must receive their training in large part after the college doors close upon them. I do not wish to be understood as implying that this state of affairs is due to our teachers, for most of them recognize the fact just mentioned

and are doing everything in their power to overcome it. The trouble is with our system of education as a whole, but more directly the body politic, which has, ever since mind training began, given preference to the ornamental rather than the useful. Nothing has done so much to weaken this idea in the human mind as science itself, and nothing can so strengthen science in what it can further do in this direction as to teach its broad practical application to the affairs of life. It would seem, therefore, that the time is ripe for some decided action leading to a clear understanding as to the methods whereby the increasing demand for men trained in applied botanical work may be met. The national government is spending close to a million dollars a year in this work, and the demand for the right kind of men far exceeds the supply. In fact, the government, through lack of properly trained men, has been forced to undertake the training itself, a course which would not be necessary if the proper co-operation could be secured from the colleges. Here is a subject which might very properly be taken up, as it is one in which most of us are either directly or indirectly interested. I have dwelt upon it somewhat in detail, as it seemed to me the foundation upon which all other matters are built. With the men that we have and the men we can get, what then are some of the problems with which applied botany in the future can hope to deal?

With the opening of new territory within the past few years there has, of course, developed a need for still broader work, for we are now especially pressed for tropical investigations, which we are unable to meet through lack of properly trained men. Moreover, another and equally important field has been opened through the rapid extension of our population into the arid and semiarid regions, and the demand from these people for light on many subjects, which we are illy prepared to give. It seems to me that everything points to the fact that the heavy demands for applied botanical work for the next fifty years will be mainly in the field of plant physiology and pathology. The two subjects are intimately connected, and while there will, of course, be many physio-

logical problems pure and simple somewhere and at some time, these problems will be found closely associated with pathological phenomena.

Reverting to our western conditions, arid and semiarid, there are many questions which demand immediate attention, and which have an important bearing on the future development of the country. Such, for example, are those which have to do with the water supply of plants and with the bearing of water supply on plant production. Irrigation is now an important factor in our industrial and commercial development, and the problems associated with it must be reckoned with. In the past, the work in this field has been mainly of an engineering nature, such as the question of securing water and bringing it as economically as possible to the plants. Now arise more far reaching questions, such as how to handle this water in a way to attain the desired maximum results with the least expenditure of time and money. Given water, soil rich in plant food, and proper heat and light, the productive power of plants is great if the requisite knowledge is present as to how best to utilize what nature and art supply. Such problems as these must, for the most part, be worked out in the field, but the field must be made to take the part of a laboratory, for laboratory methods on an extensive scale must be employed.

What is the effect of varying quantities of water on the longevity of a plant; how is the production of fruit and foliage affected by the water supply; how far can the time of ripening, color, keeping qualities, and resistance to diseases and insect attacks be controlled through the ability to control the amount of water used? These problems, on their face, appear simple, but they are important ones, and to throw light upon them there must be most careful studies in a number of fields. Chemistry will, of course, enter into these studies, but it must be a living, vital chemistry, if I may use such a term, and not the mere question of ash determinations. Closely related to the problems involved in water supply are those which have to do with so-called alkali soils and their effects on vegetation. A question of supreme importance to the development of our western country is to

know more of the effects of various mineral salts, severally and combined, on plants. With such complicated problems as present themselves to the investigators in this field, it is not safe to base any conclusions on the knowledge of how plants behave in a laboratory where the action of a single salt, or simple combination of salts has been determined. The fact that individual plants show marked differences in their ability to resist the poisonous effects of alkali salts opens up an interesting field in the matter of plant selection and plant breeding. Wherever crops are grown in alkali soils, especially under irrigation, the power of certain of these plants to make better growth and give greater yields than their nearby neighbors, has been noted.

Profiting by these facts, an important field opens in the matter of developing alkali resisting plants, having the power to give relatively large yields in the presence of an unusual amount of soluble salts in the soil. Some interesting suggestions have recently been made in this direction by the work of Kearney and Cameron, and the same investigators have also pointed out the great economic advantages that may result from the combination of two or more salts which, individually, may be dangerous, but when combined have the opposite effect on plant growth.

The nature of the problems here briefly reviewed shows the broad scope of physiological investigations, for they merge at various places into ecology, pathology, chemistry, and physics. There is, furthermore, shown the futility of attempting to solve such problems along one line of cleavage, for it cannot be done with any degree of satisfaction.

Aside from the problems mentioned, the field for applied work in plant nutrition is large. The physiological roll of mineral nutrients in plants is little understood, and the effects of mineral nutrients on growth, singly and combined, should be explained. The power to control profitable plant production through a better knowledge of plant foods is recognized, but there is yet much to do in the matter of making clear little known or obscure questions on this subject. In the problems connected with the acquisition of nitrogen, however, are found some of the most important practical ques-

tions in this field. The results already accomplished in this direction, through the use of proper nitrifying ferments, have not been as successful as anticipated, but this does not indicate that future work may not be made more profitable. There is much to be done in the way of investigating the life history of bacteria inhabiting the root tubercles of legumes, for unless such questions are better understood it will not be practical to apply our knowledge in any far reaching way. The time will doubtless come, however, when our knowledge of the nitrifying organisms will be sufficient to enable us to apply, in a much broader way, the use of pure cultures of such organisms in general field work. Already encouraging results have been obtained in this direction, and steps are being taken to extend the practical application of these results as rapidly as circumstances will warrant. The future success of this work will no doubt depend, in large measure, upon the ability to grow the nitrifying organisms in large quantities and at an expense which will not curtail their use; and then to be able to distribute the organisms in such a way that the farmer himself may use them at little expense, but with sufficient profit to pay for his trouble. It will be seen, therefore, that while these may appear as simple problems, when looking at them from the purely utilitarian point of view, there is much work to be done in the laboratory, under rigid scientific conditions, before satisfactory conclusions can be reached.

It is in connection with the problems bearing on plant breeding and the selection of plants better adapted to meet the special requirements, that some of the broadest questions of applied botany can be brought to bear. While, as already explained, plant breeding is more or less of a composite science and, to a certain extent, an art, physiology is after all the basis for most of the work. There is much need of further research work in the field of reproduction and heredity, especially with a view to obtaining light on many practical questions which are bound to come up within the next few years if applied investigations are to have their proper place. Admitting the necessity of these, it would seem as if some of the more practical problems that must be considered within the

near future will have to do with obtaining light on such matters as the securing of plants adapted to particular purposes and to particular regions. As population increases and competition in all lines of agricultural production becomes keener, the need for securing plants better adapted to certain conditions and which can be produced at a minimum expense will become greater and greater. In the south there is already felt the urgent need for improved kinds of cotton varieties that will give greater yields and finer staple, in order that cheap labor of foreign countries can be competed with. There is also a demand for improvement in other plants adapted to the south, which will enable the southern agriculturist to more generally diversify crops.

We have been told that within a comparatively short time the United States will not be able to grow the amount of wheat, and possibly other cereals, needed for consumption. These statements are based on our present yields and the increasing demand of population. If the figures be true it would seem important that attention be drawn to the securing of varieties of wheat better adapted to existing conditions and yielding larger quantities of grain. This is a perfectly legitimate field for applied botanical work, and what has been accomplished already indicates that much can be done in the direction of largely increasing the possibilities of this country in the matter of cereal production. What is true of cotton and cereals is equally true of other crops, so that it is unnecessary to go into detail as to what might be accomplished in the way of causing not only an increased output, but improving the quality of the output as well.

Associated with the work of plant breeding, and more or less closely related to it, is another important field which has for its object the studies of life histories of principal crop plants, with a view to determining the environmental conditions necessary for successful growth. This work, of course, covers a broad field, as it involves knowledge of requirements of climate and soil, and really merges into the broader territory of ecological work. The problems involved carry with them not only the question of plant adaptations, but the matter

of introducing new plants from foreign countries and the broader dissemination of plants already existing here and which give promise of more profitable yields under changed conditions of environment.

With proper studies of soil and climate, the possibility of more intelligently defining the areas adapted to certain crops will become greater. After all, however, the vital questions involved in this problem will depend largely upon actual experimentation, as those most familiar with successful crop production know how unsafe it is to generalize in such matters. The success or failure in growing a certain crop often depends on differences in soil and climate so slight that present instruments cannot determine them, although the plant, with its power to respond to immeasurable stimuli, can do so.

In the field of pathology the opportunities for applied work in the near future will be great. We are all agreed that the more or less empirical methods of handling plant diseases has about reached an end. It served a useful purpose in pointing out practical ways of controlling some of the common and destructive plant maladies, and enabled those who were looking to the future to create a sentiment making possible better and more far reaching work. We do not agree with those, however, who hold that the time is at hand when we can afford to stop the propaganda of actual field treatment. In fact, we are more and more convinced that one of the greatest opportunities for bringing home the practical value of pathological studies will be to undertake at once, on an extensive scale, what may be called demonstration experiments. A propaganda in this field, conducted by and depending upon publications alone, no matter how practical such publications are, will necessarily be slow; but when the work can be carried into the field and be made to serve as an object lesson, the impression made is lasting and convincing.

One of the problems, therefore, for the future, in this work, is how to insure the application of the investigations made, and to so conduct the work that it will all go toward the development of a system of plant pathology, which will

build up and strengthen the science. Recognizing the importance and necessity for the application of remedial measures in the form of fungicides, to which the foregoing remarks mainly apply, we may turn our attention from this art, for so it is, to other methods of applied work in this particular field of botany. The future of other lines of applied work all hinges on a recognition of the possibilities within the plant itself, its plasticity and ability to change, the effects of environment and the means of controlling environment, to the end of securing desired results. Here again, the breeding of plants will enter and furnish the means of overcoming diseases by selection of resistant varieties from those already existing and the creation of new varieties having the desired characteristics. Here, too, arises the question as to what factors govern resistance to disease and how these factors may be determined and controlled. Why is it that the most successful production of a plant is often reached when its ability to resist the attacks of organisms or to succumb to functional disorders is at a minimum, or, expressing it in a somewhat paradoxical way, why is a plant weakest when it is apparently most vigorous?

Proper knowledge on many of the problems involved in the questions here presented will make it possible to apply it in securing crops at far less risk than at present, and will tend to make the occupation of plant growing less a matter of guess work than it is now. No rational system of pathology can be developed, furthermore, without due attention to proper field hygiene, the rotation of crops, and other similar means of surrounding the plants with healthful conditions. Some of the principal lines of work, therefore, in the future, in this field, will be in the direction of giving broader application to existing knowledge on the question of treating plant diseases by means of fungicides, to the development of new forms better able to resist diseases and suitable for special conditions, to the handling of plants, so as to better adapt them to conditions at the present, and to the improvement of field methods to the end of securing vigorous growth by furnishing conditions needful to the highest production of the crop.

Of the future problems in other lines of applied botany, it is not necessary to speak in detail. Suffice it to say that in the broad field of forestry, agrostology, and pharmacology, systematic botany will always play an important part. In agrostology, especially, which has now come to be understood as covering the study of not only the true grasses but all forage crops as well, the field for applied work is exceedingly broad. With the rapid settlement of the east and the utilization of our arable western lands for crops, the area for the maintenance of stock is becoming less and less. Thus is developed the necessity for better understanding the methods of improving and maintaining our pastures. The production of large quantities of forage from given areas, and the improvement of our range lands to the end of enabling them to support an increasing number of cattle, are some of the other important problems in this field. These broad questions will, of course, involve to a certain extent systematic studies of native floras, the changing which may result from the shifting of plants from one place to another, and to opportunities that may arise from the introduction of new forms and the improvement of those already present.

Within the last few years it is fortunate that a well defined forest policy has been developed, so that in the future the growth of this work will be largely in a distinct field. Botanical investigations, however, will always play a more or less important part in all matters pertaining to the subject, especially systematic studies of the tree floras and the application of these studies to the questions having to do with reforestation and the protection of existing forest areas. The applied botanical work in connection with future problems in pharmacology, will be considerable. Systematic studies of plants used in pharmacy, the introduction and cultivation of such plants with a view to increasing their usefulness, all come within this scope of applied botanical research. The study of tropical plants, which has already been referred to, is also bound to play an important part in the near future in the matter of the development of our insular possessions. As yet, we have very little satisfactory information as to the possibilities of tropical agriculture, especially as concerns

our own country; and it would seem that some of the first problems will have to do with systematic studies of the field to determine existing possibilities, with a view to applying them in the near future in a practical way. There are numerous practical questions having an important bearing on all tropical work which must receive attention before any final conclusion can be reached in regard to the successful growing of crops in these regions. These questions have to do with the interrelation of the plants themselves to the development of the existing system of tropical agriculture, so that really a systematic study of our tropical floras would seem one of the first requisites as offering a key to the future solution of other and more general problems.

Bacteriology, in its relation to surgery and sanitation, has passed out of the field of applied botany, but problems will still arise. Systematic studies of bacteria may be essential to the successful prosecution of certain phases of this work. It is hardly necessary to refer to these questions in detail, and I may, therefore, conclude this review of the possibilities of applied botanical work, as we see them, by again calling attention to a fact that becomes more and more evident as we look into work of this nature, and that is, how thoroughly we are all dependent on others for aid, not only in our own field of science but other fields as well. Like our social fabric, science for science's sake, and applied science, are becoming more and more a delicately complicated system, capable of endless harmonious expansion if viewed aright, but leading to possible endless discord if handled wrong. How essential, therefore, that the broadest spirit of tolerance be cultivated, nor no matter how small or how humble a piece of work is, somewhere and sometime it may be made to form a part of an harmonious whole. While this is a practical age, and while the demand is heavy for practical results, we should not forget that there are ages to come after us—ages that may demand something different from what the majority of us are producing now; and for this reason the laborer in some obscure field should not be forgotten, for it perhaps may be that his work, now little known or understood, may in the future take its place in the building up of mankind.

FARMING IN THE TWENTIETH CENTURY.

BY E. P. POWELL.

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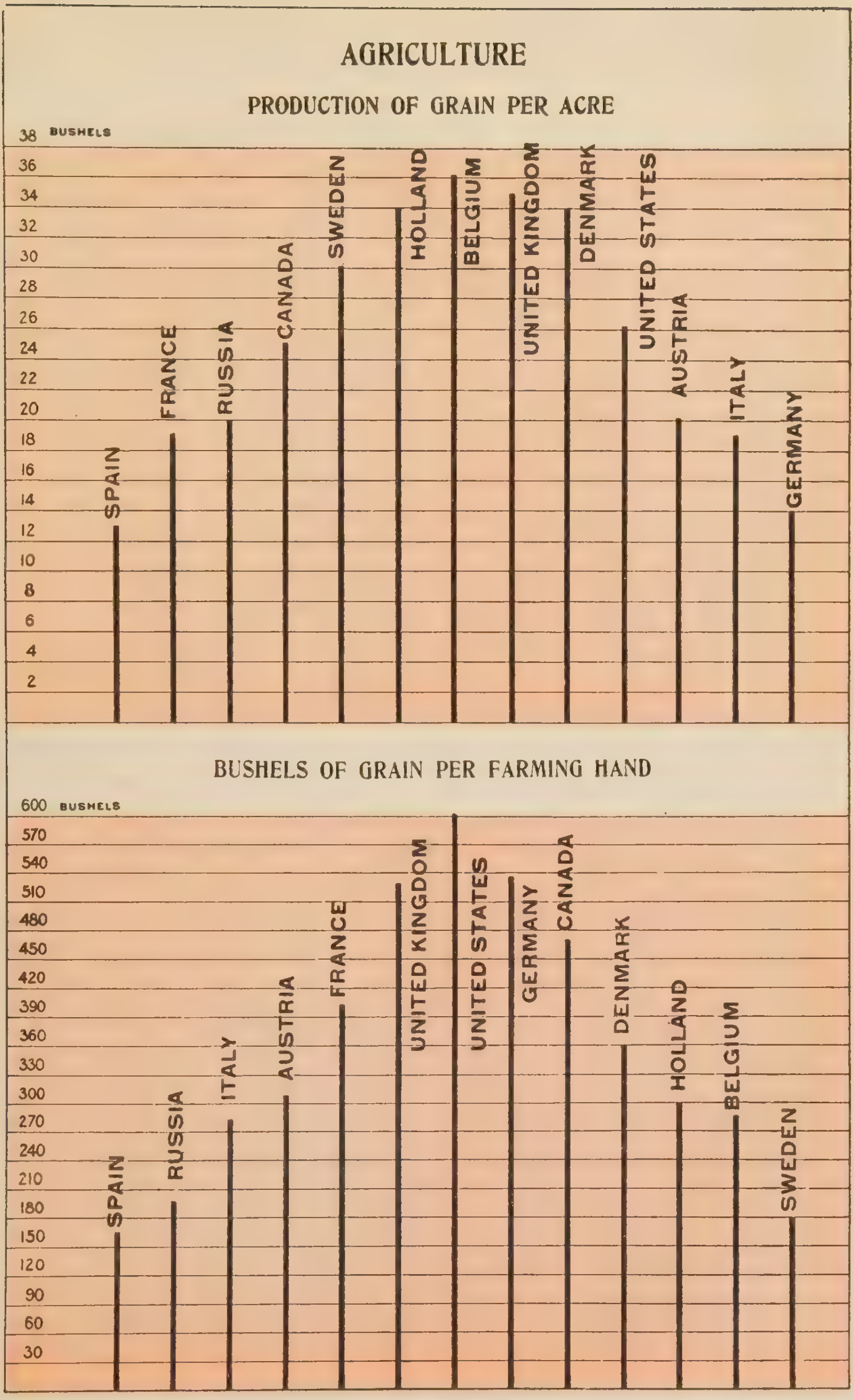
Farming in the nineteenth century began in the age of cord wood. It ran into the age of coal and steam—about 1840 to 1850. So far the steam age has lasted about fifty years. It has succeeded in that short time in transforming farm life and revolutionizing all life.

It took away home industries. During the quiet age of cord wood the farmer made nearly everything he used, from the clothes worn by his family to the soap and candles and carpets. He raised his own mutton, while his wife carded their own wool, spun their own rolls, wove their own yarn and sewed their own clothes. A girl of ten had a homemade dress with tucks in it, and the tucks were let out each year as she grew taller. Boys were clothed in homespun linsey-woolsey. Steam took soap making to one factory, candle making to another, carding to a third, and weaving to a fourth. So it soon came about that the farmer must buy everything he used to manufacture, and he must manage to sell something to buy with. The age of barter passed into an age of trade. Home industries were narrowed down to digging and cheese and butter making. Then came the cheese factory, and the creamery. I do not say that farm life could not have been readjusted to the new age, but it could not have been done at once; and it really never has been done at all. Farm life became less attractive, and rural homes more dull and monotonous. This is the chief trouble to-day—that our farm home life lacks the varied industries that it once included.

The steam age built up great cities. Steam power can not be carried far. It must run its spindles in close prox-

imity. The factory, therefore, grew bigger and bigger. Factories and manufactories required shops and stores, and tended to agglomerate population. Our cities doubled and trebled; and with them grew not only business but misery, and not only wealth but poverty. To-day one half the residents of cities are dependent on fluctuations of business for a living. One third of their people are paupers or criminals. Three generations, we are assured by statisticians, will run out a city's population if it be not steadily renewed from the country. The herding instinct, which had been decreasing, has of late increased in America. And it has been our farm boys and farm girls who have fed and still feed city life. They have left the farms as fast as possible for more attractive chances. Yet Abbott Lawrence tells us that "ninety business men out of a hundred fail once, eighty out of a hundred fail twice, and seventy out of a hundred fail three times." The attractions of business life are on the surface. A city is like a maelstrom for most who enter its circle of influence. We began in 1790 with ninety six per cent of agricultural population. This has gone on decreasing, decade by decade, till now we have less than forty per cent.

The steam age massed wealth as it never had been massed—except in Rome, by the hand of war. These two powers alone, steam and war, have been able to pile up enormous fortunes in the hands of the few. A ton of coal stands for 1,300 horses, for a day of ten hours; but a factory will consume one hundred tons a day—equal to using up 130,000 horse power. Vanderbilt's engines use 10,000 tons a day; that is, Mr. Vanderbilt every day drives thirteen millions of horses. Never before has such extreme inequality prevailed in the distribution of wealth as in this country. The individual fortunes of our day, mainly gathered in the last forty years, overtop all that have been known before and render the standards of comparison which the world has used for the last two thousand years ridiculously inadequate. And this living for accumulation has touched farm life. Our homes are run largely on the speculative spirit. Crops are raised to get rich on, at the expense of crops to get comfort out of. But farming has not been able to compete with


AGRICULTURE
PRODUCTION OF GRAIN PER ACRE
38 BUSHELS
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
SPAIN
FRANCE
RUSSIA
CANADA
SWEDEN
HOLLAND
BELGIUM
UNITED KINGDOM
DENMARK
UNITED STATES
AUSTRIA
ITALY
GERMANY
BUSHELS OF GRAIN PER FARMING HAND
600 BUSHELS
570
540
510
480
450
420
390
360
330
300
270
240
210
180
150
120
90
60
30
SPAIN
RUSSIA
ITALY
AUSTRIA
FRANCE
UNITED KINGDOM
UNITED STATES
GERMANY
CANADA
DENMARK
HOLLAND
BELGIUM
SWEDEN

manufactures and commerce. They have the steam; the farm has not. Farmers will always in the steam age be the relatively poorer class.

The steam age has legislated for commerce and manufactures in preference to agriculture; that is, the laws have been made by steam. It would be strange if a man that drives thirteen million of horses didn't drive faster than a man with one horse, or with a two horse team. Protection has been demanded and secured for the factories, which do what we used to do in our homes without asking for protection. As an employment apart from others, agriculture has demanded and required very little of the time of congress. Nor is there the least hope that the increased legislation demanded by farmers will be of much advantage. Laws lie about us as thick as leaves in the woods, and nobody knows one tenth of the annual output. Is it any wonder that a class is growing among us that denounces all laws, and is ready to smash the whole machine of government? Farmers are not interested in selfish legislation, but in stopping class legislation of any sort they are deeply concerned.

The worst of it all is that, while steam and coal have transformed everything else, they have left our education almost exactly what it was. If we send our boys and girls to school they ought to be taught what will make farm life intelligent, interesting, and successful. What we need to know and have known on our land, for successful agriculture, is chemistry—a knowledge of soils, manures, grains, waters; botany—plant growth, plant food, plant habits; zoölogy—knowledge of animal life and animal structure. But what common school gives these things? It would amaze our school boards beyond measure to have such things displace dear old geography—with a large amount of grocery and store knowledge. Surely, the teaching of practical school gardening would be as valuable as setting the pupils to memorize the height of the principal peaks of the Rocky mountains. But are not these sciences too abstruse and difficult? Can we get the pupils to comprehend them, or get teachers qualified to instruct? Chemistry and botany are knowledge of the things children see and handle most. In their elementary

form they are more simple than geography or grammar or arithmetic. Such sciences consider stones, flowers, trees, insects, birds, brooks—exactly what our children long to study. As for teachers, what are our normal schools for? To make merchants? or farmers? Or are they to turn the whole population into middlemen and consumers? Why can they not furnish teachers of geology as easily as teachers of geography? Give a boy a right sort of schooling till fifteen, and you cannot coax him away from the land. Everything he sees or touches or hears is full of delight and interest. "Rural education," says U. S. commissioner of education, William T. Harris, "is now the greatest of all our national interests—and it is colossal." But he does not say that the trouble with which we have to deal is not too little education, but too little of the right sort.

It is very probable that the age of coal and steam is near its close. The English parliament has appointed two commissions to determine how long English coal would endure. The conclusion is that it will not last much beyond one hundred years longer; but it will not endure the increased draft of progress one half that time. Professor Orton, the ablest authority on American coal, tells us that all known deposits in this country, with the exception of the Pittsburg seam, will be practically exhausted for keeping up with increased demands by the middle of the present century. The territory that holds coal deposits is pretty well known and measured. There are about 400,000 square miles of the earth's surface known to be carboniferous. Estimates cannot be exact, but they are not far astray. The coal famine of Europe has begun already, and the draft on American coal enormously increased. We are rushing by steam toward the end of the steam age. It has been a fierce, furious age, full of tremendous struggle of man with nature—and man has been victorious. The enormous task of girding the world with steel has been accomplished. We have sounded the depths of the oceans, dropped cables under their mountains of waters, and have made neighbors of all mankind. Can we conceive of an age less plunging, less turbulent, less cyclonic; an age in which we gather up our achievements, and turn our minds to make all men happy

rather than a few wealthy; an age of culture, of peace, of love? At any rate there are signs that the work of steam is waning. It no longer pays to build railroads. Very few have been built for the last ten years. The network is woven. The railroad comes about as near our farms as we can expect. It still costs the farmer more to get his produce to the depots than it does to have the same produce carried to New York or Boston.

We have no quarrel with the railroad age. It was necessary, for fifty years, to subsidize the world to get these marvelous iron roads. But now the want is better dirt roads, and a different power from steam. The government granted favors and gave our public lands to railroad corporations; now the united force of the American people must create solid roads for short haulage. Europe is ahead of us; all the civilized world is ahead of us. We have for common roads only such as were used in colonial days. The loss from their use in New York state alone is annually, from haulage of a single crop, not less than ten millions—besides loss in taking prompt advantage of markets; loss in vehicles, harness, and animals; loss in comfort, health, and decency—while our annual road tax is almost absolute waste. The twentieth century will surely see the bog road system abrogated. It will see the American farmer moving as smoothly as the middlemen move on their steel rails, or merchants on the Telford pavement. It will cost us five dollars an acre from ocean to ocean to get such roads; but it will add twenty dollars or more of inherent value to each acre, and ten dollars to the salable value. But, aside from pecuniary considerations, we want agriculture lifted out of the mud. We want the same grade of comfort everywhere that is possessed by the cities.

The second great need of the farmer is, as already said, a new power in place of steam—a power that can be specifically adjusted to farm wants. Electricity is possibly just that power. In the first place, electricity can be carried a long distance from the plant. You cannot profitably carry steam one quarter of a mile; you may carry electricity ten miles, or a hundred. Steam concentrates labor, and therefore population. Electricity distributes force, and therefore population.

The electric age will put an end to the packing of people like sardines in tenement houses. It will take the people to the food, instead of carrying all the food to the people. Instead of factories, home life will be emphasized. Work will not need to be done so exclusively at great centers. The miseries of gorged streets and the problems of municipal misrule will steadily lessen. But electricity will do more. Already in the prairie states they are building short haulage roads, to drag farmers' wagons direct from the door to the market. We will soon see all over America strings of farm wagons moving as we now see long trains of freight cars. Power will be taken from the same plants to run barn and house machinery, and to heat and light houses—possibly to do much more than that.

Farming will have not only the roads and the new power; it will have the schools. I will picture what I believe to be the common school of the twentieth century. There will be handsome schoolhouses in abundance, placed in the center of large gardens. The children will study books half a day, and things the other half. The brain will not get any more training than the hands. Manual culture, which is already a part of the school life of a few towns, will be a part of school life everywhere. The school will have its shops and its gardens—and to use tools will be the chief end of culture. Man got away from the monkey by his power to make and use tools. He goes back to the ape when his hands have to be cased in gloves and his brain is ashamed of decent labor. In these school gardens botany will be applied to horticulture. In the shops our boys and girls will learn to create things. The trouble with education now is that it divorces knowledge from work—the brains from the hands. I asked a college boy the other day what he intended to do when he graduated. "Well," he said, "I've thought of everything under the sun, and I don't believe I could succeed at anything. I guess I'll have to teach."

In the twentieth century the glory of American education will also be a thorough knowledge of economics, civics, and history, applied to good citizenship. Colleges will surely be a part of the common school system, and just as full of modern

life. I believe we shall see the days when boys and girls, who are in our common schools together without damage, can be co-educated in all other grades of school life. The farmer will then not have a separate and specific college for agriculture, while the rest have one for mental culture; nor will college boys in those days be ashamed to look ahead to farming as a profession. There is no occupation that requires as much wit and educated tact, and as much positive knowledge, as farming. When we get the schools, we shall get a style of farming that will be as keenly intellectual as our present style is wasteful and unintelligent.

Having won the new power and the schools, agriculture will control the laws also. Tariffs, if they exist at all, will protect production as much as they protect traffic; they will encourage the farmer as well as the hired laborer. I think that by and by we shall be able as agriculturists to understand that the steam age has been naturally and needfully in the interest of manufacturers and traders. Jefferson insisted that the future of the republic depended on agriculture—that the great aim of the people should be to develop land culture. The best way to develop agriculture is through equality. What we need is to obliterate half the laws rather than to make more. Every sun that shines on America sees about one hundred new statutes enacted, on an average. It has become a passion with us to legislate. Our legislatures will probably hereafter meet less often, while all laws of general importance will possibly be referred back to the people to be confirmed or vetoed.

Our homes will never again be of the old industrial type. We must adjust ourselves to the new days and new things. With proper agricultural schooling we shall learn to adopt diversified crops, instead of speculating or venturing on one or two. Our houses will be, like our schools, made up of more shop and garden life. There is no reason why every home shall not have laboratories and museums as well as libraries. Along our homes will be, not only good public driveways, but ornamental roadsides. A rural district in Michigan took the initiative in another way. A telegraph line of eight miles was provided, connecting a large number of farms with the post-

office and depot and general store, so that each farm was brought into immediate relation with every important interest of the town. If a farmer expected an important letter he could wait till notified of its arrival. The total cash expenditure for the outfit in this case was $200.

This experiment was in the eighties. Since that time we have seen a revolution that has reversed nearly every phase of farm life. Independent telephone companies are constructing lines that connect farmhouses in social and economic routes. These already number many thousands, and are irregularly spread over New England, New York, and the midwest as well as the Pacific states. The idea is spreading so rapidly that the number of 'phones placed in country houses is said to have doubled in 1899. The cost to the farmer is from ten to fifteen dollars a year, including rental and supervision of the lines and instruments by the company or contractor. In a few cases the lines and the instruments are owned by the farmers themselves. The social consequences are so great as at first to overshadow the economic. Farm isolation, which has been the chief drawback of agriculture, is abolished. The remote farmhouse is brought within speaking distance of a dozen neighbors, and in all probability a village or town. Long distance routes are easily formed. The farm wife hears the cheery good morning of her neighbors and gives it in return. Friendly gossip and the news are transmitted as easily as over the fences of city lots. Telephone tea parties are said to be in vogue—while the women of a circuit sit by their 'phones, drink their own tea, nibble their own cakes, and distribute the gossip. Music is as easily transmitted as conversation. Phonographic concerts are a common affair. The writer has heard the fiddle, the parlor organ, and the piano at a distance of a mile. A circuit generally consists of about one dozen houses; but two or more of these circuits can be connected, and altogether have a long distance connection with the general telephone service of the United States. In Ohio a minister has his whole parish wired to his church. There is really no reason why the country parish shall not be served by the ablest preachers in the land. But the economic consequences are still more important. The

farmer can now buy and sell to customers in remote towns—himself not leaving his home. He consults prices by 'phone, so that speculators cannot readily outreach him. He is brought within conversational distance of the great markets. On every one of these circuits or groups of circuits is sure to be a physician, and probably a grocer.

It is rapidly becoming possible for a physician to live far away from any town and yet have a large practice. The tendency is to take away the importance of city residence and even of that old fashioned grouping called the village, which was originally only a collection of houses of laborers around the villa. The drift to congested towns is reversed. Population is spreading out. The increased uses of electricity as a motive power combine with the telephone thus to spread out and equalize the distribution of population. Nor is even this the end of the evolution. A new era has begun in social grouping. We are beginning to hear that this or that family belongs to a certain circuit. The social unit is no longer the town. The farmer of the twentieth century will be known not by the village nearest his land, or by the city to which he carries his products, but he will be known by his 'phone connections.

The source of power for the establishment of plants will be waterfalls, tides, and windmills. Storage batteries will collect the current on windy days from the million windmills in the United States to be used when and where needed. A whole state can be supplied with half a dozen plants. The problem of supply involves no serious difficulty.

But we must not fail to look indoors. When electricity enters our households to do a very large share of our kitchen work, another problem will be hurried toward solution. The most serious question now affecting American life, after that of waste, is help. We are just now in the terrifying crisis. It is growing more and more difficult to secure for our households competent assistance, while the need of good help is greatly increased. It is impossible to build the ideal home simply because we must as a rule admit freely into our houses persons bred in vulgarity, or our wives must do work that stands in the way of higher work, culture, rest, and enjoyment. The advent of a power that can wash our dishes, wash

our clothes, do our cooking, churning, sewing, and that without noise or dirt, is to be hailed with acclamations of joy. There is no doubt that we are approaching an entirely new age of homebuilding and housekeeping. Electricity will help us to get rid of the invasion of our homes by a purely menial class. At the same time let us not forget that this menial class will be itself helped to escape from a subject position by the same new power. Smaller homes will be brighter, cheerier, cleaner, and warmer, as well as less expensive. Coal bills and oil or gas bills will be abolished. Fuel and light will be so lessened in cost as to be practically, like education, free.

Those who attended the St. Louis World's fair will remember with special delight the quality of certain foods offered freely to the passing crowds, and that were cooked in ovens where the only power used was a current of electricity. But equally delightful to remember is the fact that, as electricity abolishes superfluous heat and dirt and waste of fuel, it introduces the beautiful. The electric fountains—who will ever forget them? Decorative lighting of our houses and lawns will produce effects beyond our imagination at present to picture. So the useful and the ornamental blend—unite to make our lives better worth living. Word comes that electricity is to be applied to the working of factories in Germany and of dairies in England. Two Belgian scientists have patented a method of heating, melting, and refining metals by electricity. What is to follow this discovery it would be difficult to foresee. But the marvel is that while our professors are saying what is impossible, or pointing out limitations, the impossibles are swept away.

There is, however, no outlook more pleasant for us than the effect that will be produced in the way of sanitation and health. When our homes are heated by electricity, says a noted writer, consumption and many other diseases will wholly disappear—not in a day or a single year, but as certainly as yellow fever disappears before a frost. Its uses in the household will be to ventilate it by means of fans, to supply power for pumps, sewing machines, dumb waiters, elevators, bells, and cooking apparatus. The idea is not abstruse, nor is it visionary. The removal of stoves and furnaces and gas pipes,

and attendant dust and bad air, will easily revolutionize the sanitary conditions under which we live. Our heating and lighting appliances of the steam age are positive elements of danger. It is almost impossible so to conduct our homes as to avoid unsanitary conditions from coal, steam, and gas. Our worst diseases most prevail in winter months—when our houses are most closed.

One hundred years ago Burke said that America could never be represented in parliament: "Some of their provinces will receive writs of election in six weeks, some in ten. After election, if ships are promptly ready, it will take them six weeks more to reach London. Meanwhile parliament has far, far advanced its business—nay, perhaps been dissolved. So that before their arrival they are themselves discharged of duty, and the writs issued are on the way for their successors." This was the age of wind power. Then steam power, which shortened the passage of the Atlantic from six weeks to six days. Electricity may do even greater wonders than this; yet as a power it belongs not to commerce, but to agriculture. It is not so much the power that links nations as the power that links farm to farm; that does what, after all, steam cannot do—move in all directions: up hill, or down hill, and across lots. Mr. Frank Hawley tells us that the railroads of the country are only waiting for improved accumulators to substitute electricity for steam. And he is confident the change will soon be made.

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